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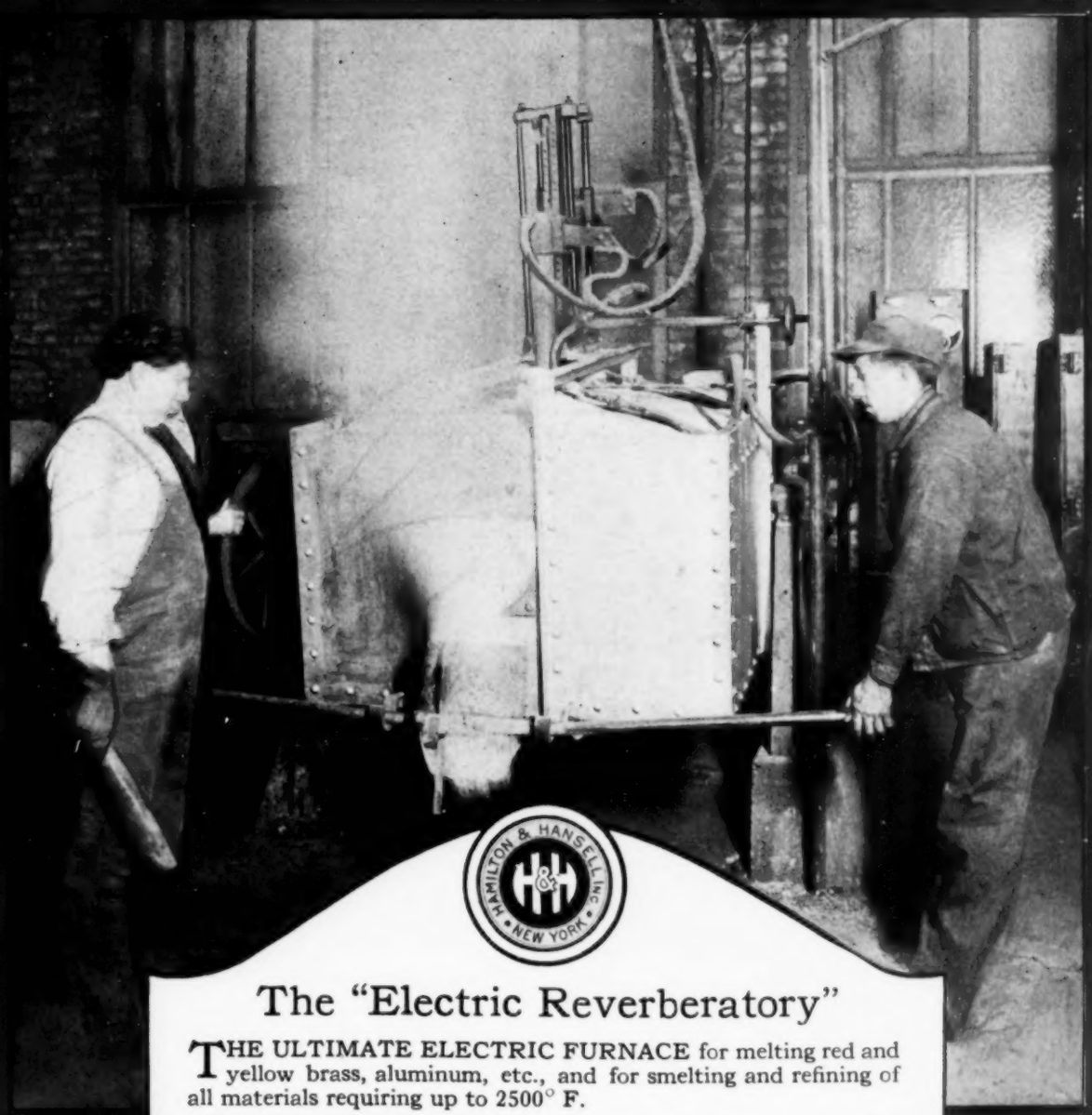
METALLURGICAL ENGINEERING



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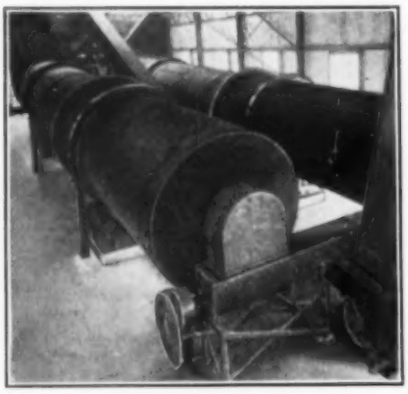

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Sorts and Conditions of Men

WHEN we speak of all sorts and conditions of men we are likely to think more of their conditions than we do of their sorts—and we make a mistake in the lead. We can't gage the worth of a man by what he makes any more than we can gage the worth of an article by what it brings.

Let's cite an example on exposition of the latter statement. Imagine the affluent Mr. P. LUNJER walking into the establishment of a leading antiquarian on Fifth Avenue in New York. P. LUNJER is a patron of the arts, he is a collector, known as an amateur—in the true sense of the word—and his gallery is famous. He has lately returned from Italy and Spain, where he has been traveling and "picking things up."

The dealer in antiques has returned still more recently from abroad, where he has been over the same route. Two weeks after Mr. P. LUNJER visited Seville the dealer was also there, and he found in a second hand furniture store a picture that looked like a genuine Ribera. He bought it for ten dollars after finding out where it had come from. Then he spent a couple of days getting attests from notaries, and set sail for New York.

Mr. P. LUNJER is entering the Fifth Avenue door in response to a special invitation to be the first one to look at the dealer's great find. It is evidently designed to represent St. BONIFACE the Hospitable, and is a genuine Ribera without doubt. The curators of a number of museums recognize it as such and so does Mr. DAUBLESS, the eminent art critic. The dealer hates to let it go, but if Mr. LUNJER will permit him to exhibit it for six months he will let him have it for twenty thousand dollars. Mr. LUNJER does not want to wait so long: he wants it for his gallery immediately, and although it upsets the dealer's plans and he never meant to do it, he is finally persuaded to let Mr. P. LUNJER take it home with him in his automobile for twenty-five thousand dollars.

There we have a canvas that sold twice within three months, once for ten dollars, and once for twenty-five thousand. Whatever the value may be, the selling price does not indicate it.

It is very much the same way with men. We know individuals drawing ten, fifteen, twenty, and twenty-five thousand dollars a year that are not worth it at all outside their present jobs, and the only reason they get their pay is that somebody is an easy buyer; thinks himself a rare judge of men, mistakes boasts for performance, and—of such are our Feeble-Minded Heavy-Weights. On the other hand we know still more men who are pegging away at tasks that it would be flattery to call mechanical, and yet there are potentialities within them to do great things. They are ready, willing, and anxious to serve with all their hearts, but the purchaser of their work does not see their value. He can't recognize their capacity. He has never even put them into a frame and looked at them.

Of course every one of us who would succeed must "hump himself" and look around occasionally. It is very well to preach the gospel of obedience, but obedience is merely an incident in the great art of getting along. Every man of affairs knows the misery of learning that he is to blame if things go wrong, from assistants who can't see the greater importance of keeping the whole establishment going right. If a lamp is upset and the house is afire it is more important to put out the fire than to learn who upset the lamp—and yet a great many persons can't understand this.

Every year there are hundreds of thousands of boys who leave school and go to work. The first desire of course is to work like a man and to get a man's pay. If he can feed a printing press or operate a passenger elevator he must first prove himself by being able to stick at it. Then comes the subtle gift to see that the work, no matter how well it pays, does not require intelligence; that it does not call for head work, and that if we spend our lives with our heads in idleness, our heads will not work when we want them to, either for us or for anybody else. So the mentally inert and those who lack the gift of faith in themselves stay along with those of feeble wit in the elevators or at feeding presses while the ambitious boys look for jobs where they can grow.

In the great ranks of labor these two sorts of men are bunched together by employers as well as by labor unions. This is a great mistake. The man with too much intelligence for a stupid job should not be kept at it. He may be able to leave it, but this is not always possible and the fault is just as likely due to the employer as to the employee, especially if work is scarce. One great reason why the man who outclasses his job should not be kept at it is because he is bound to become unhappy and discontented, and discontent is catching.

Let us take a well-known example of intelligence tests to illustrate our meaning. A pharmaceutical establishment employed young women to pack up boxes of pills. It was a steady job. They subjected applicants to intelligence tests, and graded them in classes from 1 to 10, one representing the lowest, ten the most intelligent. The efficiency of the workers was plotted on another curve, which rose quite rapidly up to grade 5, but fell off sharply and even declined for the high grades. Labor turnover also was chiefly in grades 7 to 10. The work was too dull for intelligent girls, and if they stayed on the job they lost heart and did not work well, while the best of them left as soon as they could afford to do so.

This rule holds among men as well as among women. We have intelligence and capacity with us in the shop

and in the office. If we do not recognize it, it will probably leave us. Then when we want talent we must go out and bid for it; bid high.

Now let us recall the journey of Mr. P. LUNJER through Seville bent on "picking up" art treasures and finding nothing, and the later journey of Mr. DEALER to the same place and his purchase of a dingy old canvas for ten dollars, and its subsequent resale for twenty-five thousand dollars. Having that in mind, let us recall that we are in the market for talent; that the progress of our business, whatever it may be, is largely a matter of talent.

Do we buy this talent like a man who knows it when he sees it? Or are we such easy marks that we can't see it until somebody else bids high for it or until we can see a sheet of past performances, often truly passed and not repeated?

Demonstrated Improvement— The Best Argument for Protection

POTASH producers have appeared before the Ways and Means Committee urging a tariff of fifty cents a unit on imported salt, arguing that with this protection they will be enabled to continue the development of American potash to the point where it can meet fair foreign competition. Fortunately this industry has made a sufficient advance within recent years, or one might better say months, to make such a plea convincingly. Any infant industry which can demonstrate continuous improvement in plant processes and efficiencies can appear before Congress asking for temporary tariff protection with assurance of at least a respectful hearing from both parties.

Even its most vigorous advocates, however, do not claim that it has done all which it could have done in the way of technical improvement. Chemical control of brine plants and the application of sound physical and chemical principles have been conspicuously absent in many plants. Nevertheless certain parts of the industry have been advancing, demonstrating most effectively the value of pure science and applied scientific research.

In another way, too, this industry has, like many others, failed to do all that might have been asked of it. It is not essentially a competitive business, for the American demand far exceeds the domestic production, and will for years to come. All potash producers, therefore, will profit by active co-operation and exchange of technical information. However, instead of active co-operation, there has even been vigorous competition which has absorbed energies which might better have gone into development. This, fortunately, is rather aside from the main issue. The industry has advanced and on this basis deserves more careful consideration by our legislators than the many other mendicants now flocking to the feast.

Whether Congress will deem "national self-sufficiency" in potash important or not, one can but guess in the light of its performances toward other key industries. Since potash is a commodity made by few and used by many, and that many farmers, a cynical one might venture the prediction that a duty on potash will not be decided on its merits however great or small, but the question will particularly appeal to the free trade arguments tucked away in every legislator's equipment for use when it may increase the number of his votes.

Information on Fatigue Failures

WOHLER'S tests, published 50 years ago, confirmed the suspicion then held by constructors that beams or rods would fail under a relatively low stress if only repeated often enough. His research has since been the model for later investigators, who have sought to extend his conclusions regarding the relationship between range of stress and repetitions necessary for failure; evidently most important "practical" information. Most of the work was done with relatively heavy stresses, however, and did not disprove WÖHLER'S conclusion that each material possessed a "limiting stress" within which the number of repetitions necessary for rupture become infinite.

Infinity of course cannot be approached, but whereas the life of a bridge member, a rail, or even a car wheel might be compassed by the 20 millions of reversals attained by WÖHLER and his followers, the development of high-speed engines, turbines and electrical machinery raised anew the question of whether a recurring load, however small, might cause rupture, if only applied often enough. The Joint Investigation of Fatigue of Metals, under the able direction of Professor H. F. MOORE, has been able to show by means of dozens of tests that if the stress is not enough to cause failure in much less than 10 million alternations, it will not cause failure in 100 million. In other words, this investigation, still actively under way, has definitely confirmed the very important fact that each metal tested has a definite "endurance limit," a stress which may be applied to their test bars at least 100 million times without harm.

It is more than curiosity which impels metallurgists to inquire into the real mechanism of fatigue failure. An understanding of its nature is evidently precedent to accurate interpretation of present test data, correlation of other test results, development of short-time tests, and rational attempts toward provision of safer structures, either by more resistant materials or more skilled design.

At first it was thought that the fibrous tough elements comprising metallic articles were changed into growing crystalline particles, and these crystals then split open on their cleavage planes at the moment of fracture. However, microscopic examination has long since established the fact that metals and alloys are essentially crystalline aggregates, and there has never been any proof adduced that crystals increase in size under any circumstance of work or rest at atmospheric temperatures. Distortion under stress is known to be accompanied by crystalline disintegration rather than growth, and we even suspect that crystals are more ductile than that material which cements them together.

Secondly, BAUSCHINGER found that the elastic limit of mild steel, for instance, depended to a certain extent on its method of fabrication and heat treatment, and the figure ordinarily obtained was therefore dubbed the "primitive" elastic limit. When a specimen is subjected to stress reversals of growing amplitude, new or "natural" elastic limits in tension and compression appeared, within which the material would not fail by fatigue. This experimental conclusion suggests the hypothesis that some commanding portion of the material changes its elastic limit under alternating stresses.

However, recent studies into the ultimate structure of crystals have led to the proposal of the idea that fatigue failure is due to the spread of damage from

overstrained portions, microscopic in size. Stress concentrations at re-entrant angles and internal cavities have been shown mathematically to rise sometimes to six times the average. This fits in well with the latest hypothesis, which recognizes that metal is a complex and heterogeneous aggregate and accounts for the extreme sensitivity of the test to inclusions and surface finish, an experimental fact which finds striking support in the success one of our leading railroads has had in reducing axle failures by polishing the ends. In fact many things indicate that a fatigue break may be a property of a crystal rather than of a material; that is to say, ductile crystals are strong against fatigue, while unyielding amorphous metal has little resistance. Alternate stress therefore promotes rupture in all materials by changing ductile crystals into amorphous substance not so much by those internal earthquakes evidenced by slip planes as by tearing individual atoms from their regular locations. Under this supposition a high modulus of elasticity means a high endurance limit because the atomic motion for a given stress is correspondingly low and less liable to transgress the safe boundary; thus rubber or glass is poor, iron or steel good to resist alternating stress. For the same reason a stress between zero and +40,000 is much more dangerous than another ranging from +20,000 to —20,000.

No simple relationship between the fatigue endurance limit and any of the static properties has yet been discovered—in fact, Professor MOORE has found that ingot iron will withstand successfully 100 million repetitions of a stress equal to 160 per cent of its proportional limit, as determined from the usual tension test, yet a popular chromium-nickel analysis can be safely stressed no more than 60 per cent of its proportional limit. Other steels tested lie between these extremes, seemingly at random. Evidently further studies into the inner nature of fatigue, static and impact failure will be necessary before these tests can be correlated or a short-time fatigue test devised which will quickly indicate the reliability of new or doubtful material.

Most automobile users are sure that springs break under comparatively small shocks as compared to some of the bumps which left them whole; but is it really true that in general a few larger stresses greatly impair fatigue resistance? Does occasional annealing help or harm the resistance to repeated stress? Will a steel endure as long at a moderate temperature? Is there a relationship between endurance limit and amount of work absorbed by inelastic action? Does sudden application of load cause different results than the same total load applied in a harmonic manner? If so, what is the critical rate at which stresses may be built up? What is the result of loads which do not reverse from tension to compression, but simply range from a high pull to a low pull? What is the fatigue effect of alternate compression applied by direct longitudinal forces, in distinction to an equal stress at the outer fiber induced by flexure?

Machines have been devised for studying the last two problems, largely through a grant from the General Electric Company. Yet it may easily be recognized that the work now financed will only serve as a reconnaissance in the field of ferrous metals. It has been the experience of makers of springs, automobiles, and aëroplane-engines that ordinary static tensile results have comparatively little meaning to one anxious to predict performance of moving parts, lacking actual service tests. Since nearly all the high strength steels now being produced are subjected to recurring forces, the progressive concerns which absorb this expensive material simply cannot afford to allow this research to stop short of its goal. It is costing about $15,000 a year. If it establishes data which will allow a saving of no more than one cent for every ton of alloy steel made in the United States, its annual cost is returned to industry.

Fluoresceine and Industrial Alcohol

SOME months ago when deaths from accidental poisoning by drinking methanol, or so-called wood alcohol, were a matter of almost daily occurrence we received an interesting communication from A. E. OUTERBRIDGE, Jr., a prominent metallurgist in Philadelphia, calling our attention to a simple method of deterring men from drinking denatured alcohol of known or unknown origin and thereby running the risk of methanol poisoning. Mr. OUTERBRIDGE explained that the addition of a small amount of fluoresceine to denatured alcohol, practically invisible in the concentrated solution, gave, on dilution with water to potable proof, a yellowish green fluorescence that would immediately attract the eye and cause the intending consumer to forego his drink. It was Mr. OUTERBRIDGE'S thought that if industrial alcohol could be thus treated men would think twice before drinking it, and that accidental poisoning from methanol would be greatly reduced. He brought this matter to the attention of the Prohibition Commissioner and subsequently sent us a small quantity of denatured alcohol to which had been added 7 milligrams of fluoresceine per 100 c.c. This we transmitted to the Prohibition Commissioner with the inquiry as to the possibility of obtaining his formal approval of the method and official adoption of the formula. His reply is printed elsewhere in this issue and we are glad to note that although he considers it inexpedient to require the addition of fluoresceine, because the coloring departed on dilution might be objectionable in some manufacturing processes, nevertheless he regards "the voluntary addition of fluoresceine to a factory stock of completely denatured alcohol or specially denatured alcohol . . . to be highly desirable."

If our readers desire to observe an interesting phenomenon let them repeat Mr. OUTERBRIDGE'S experiment and add a drop or two of alcoholic solution of fluoresceine to water. The fluorescent property of the chemical is magnified to an astounding degree and renders the alcohol repulsive in appearance for beverage purposes. We are assured by Mr. OUTERBRIDGE that in his personal experience this simple method of guarding against the consumption of industrial alcohol in the factory has been very effective, and we recommend its wider adoption.

Sir or Prince

IN a recent issue of *Chemical News* of London Mr. E. TOMLINSON writes from Barrow-in-Furness in regard to theories of the color of water propounded by Sir W. D. BANCROFT.

Sir WILDER sounds very well, but it hardly reaches. If titles were adjusted to personality and achievement one should be more disposed to regard him as Prince.

Readers' Views and Comments

Library and Research Work

To the Editor of Chemical & Metallurgical Engineering

SIR:—The New York *Times* of Sunday, Jan. 9, 1921, in its Editorial Section had a very interesting article on "Engineers Join in Research Work," with a sub-head "Agencies Co-operate in Effort to Salvage Knowledge Gained in War."

While the aim of this article is to make known the co-operation of the several large engineering societies of this country in linking together their members into a vast potential force for the solution of the various problems confronting the manufacturer and scientist, it has left out a very important link in this chain of research. I refer to the library link.

We all know that today as never before scientists and manufacturers are depending more and more upon records of others as found in the printed word. Witness the growth of the service of the United Engineering Society, the generous response to the Chemists' Club for increased funds, the expansion of the technology room of the New York Public Library and, most important of all, the tremendous increase in special libraries organized since 1917 to aid large and small industries in the solutions of their problems. Now then, with the linking up of this vast reservoir of salvaged knowledge gained from the war together with knowledge that has been made available throughout past years, what greater ally to industrial research could be found?

To go back to March 25, 1915, the *Engineering Record* published an article the text of which was: "There are today in this country a large group of engineering libraries of great value *collectively* but not suitably co-ordinated." This article finishes by saying that: "To do the work would necessarily require considerable expenditure, but it would be time and money well spent."

It is not altogether unlikely that the following circumstance will be repeated many times, and to avoid it we should make a national effort to harness it. I refer to a happening in a large industrial city where a large manufacturing concern had been experimenting on a special process, resulting finally in failure. One of the men working on this process was talking with the librarian of the city about it. A smile crept over the librarian's face as he told the man that "that very experiment had been tried out before and found a failure. We have a record of that failure right here in one of our books." So because this concern went ahead blindly it lost thousands of dollars and was no further ahead.

So it goes and so it will continue to go—wasting thousands of dollars annually simply by failing first to find out whether or not the proposed process, operation or whatever it may be has ever been done before and if so what is the best way.

There are two ways that this "library link" can aid materially.

The first is by publishing weekly an index of abstracts of articles in current technical papers.

The second is the founding of a large central catalog of all technical books, pamphlets, trade catalogs and translations, carefully analyzed for every item of value in them.

This proposed catalog would be a large undertaking but by no means unpracticable. A long start has been made in the Library of the United Engineering Societies, in the Library of Congress and John Crerar Library of Chicago. This proposed library has its prototype in the International Institute of Bibliography at Brussels, which fortunately escaped the ruthlessness of the Germans and recently filed its twelve-millionth card.

Additional co-operation could be gained by linking up the several hundred special libraries devoted to special industries by making them sponsors for picking out all items of pertinent value in their collections and sending copies of cards indexing these items to the proposed central catalog.

These two schemes for increasing research work of the future have been but briefly outlined. To some these two allies of research may seem remote and unpracticable. The fact that the International Institute of Bibliography has existed even through war-ridden days of Belgium long enough to file its twelve-millionth card is indicative of the commercial possibilities of a similar scheme in this country where the machinery for its accomplishment is greater.

Let us then make a determined stand to harness these forces and set them to work. LIBRARIAN.

Advantages of Cadmium Lithopone

To the Editor of Chemical & Metallurgical Engineering

SIR:—Having been closely connected with the manufacture of lithopone and engaged in the designing of plants for the purpose for a number of years, the comprehensive article by H. R. Hanley on the production of electrolytic cadmium in a recent issue of your magazine was of particular interest to me in view of his reference to the use of cadmium for the manufacture of cadmium lithopone.

Some results from an investigation made into the commercial possibilities of producing that pigment and deductions therefrom may be of interest and value.

Cadmium lithopone in which the zinc of standard commercial lithopone is replaced by cadmium shows good covering properties and a high tinting strength —an admixture of only 5 per cent cadmium lithopone with 95 per cent standard lithopone, giving a pleasing and distinct cream yellow when rubbed out in oil.

The manufacture of cadmium lithopone follows in general the procedure for zinc lithopone, though certain precautions not required when zinc is used are necessary, and under control of the operator considerable variation in the shade and depth of the yellow color of the product may be obtained.

The use of metallic cadmium as a raw material is to be avoided, however; technically, because of the difficulties in getting it into solution as pure sulphate; commercially, because of its high cost, and Mr. Hanley's article seems to point the way to escape therefrom.

In the process of separation of the associated elements

he obtains a combined solution of zinc and cadmium sulphate apparently of approximately equal parts from which cadmium sponge is made for re-solution as sulphate relatively free from zinc.

The presence of thallium in small quantity has not been found detrimental and its removal would probably be found unnecessary.

The cost of the cadmium in the sulphate solution is, in the absence of cost figures, difficult to determine, but analysis of the methods, apparatus and man-hour figures, and with allowance for overhead and profit in the quoted prices, indicates that not more than 40 per cent, or less, of the present selling price of the metal, $1.40@$1.50, or, say, 60c., is a liberal figure at which the charge for cadmium should appear in the lithopone product. At the present prices for acid, barytes, coal, etc., and labor, and taking cadmium at 60c., the cost figure for cadmium lithopone works out at 29c. per lb., including a 20 per cent profit. This figure is on the basis of using the sponge cadmium.

On account of the high strength of cadmium lithopone and because in most commercial uses it probably would be mixed with a large proportion of zinc lithopone or other white pigment, lithopone made from the equal part sulphate solution would have color and other values probably sufficient for many purposes.

Where cadmium lithopone is thus made in combination with zinc lithopone and by reason of lower cost chargeable to cadmium than the above 60c. figure and by reason of greater bulk, the product should cost appreciably less per pound than the above 29c. figure for the cost of cadmium lithopone content of the combined zinc and cadmium lithopone.

Given a source of cadmium from which the sulphate may be made at a cost comparable with the above example, the profitable manufacture of cadmium lithopone is indicated, especially when carried out in connection with other allied manufacture, as would probably be the case.

PAUL W. WEBSTER.
Perry & Webster, Inc.,
New York City.

The Metric System and Religion

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with profound wonder, mixed with something else, the reprints of certain articles on the chemistry of embalming which you printed some time ago. Now I pick up the latest issue of CHEMICAL & METALLURGICAL ENGINEERING and note the story entitled "Easy Money From Peat." It is certainly a modern miracle. My boyhood was spent up in the State of Maine, where the original demonstration (for public consumption) of easy money by the economical separation of gold from sea water was staged. But this was as nothing compared with these up-to-date superscientific wonders.

These things prompt me to send you the following letter on the dangers of our country adopting officially the metric system. It was written to the editor of one of our metropolitan daily papers and printed on the editorial page.

> Your correspondent suggests as a topic of conversation the metric system and informs your readers that Congressman Britten has introduced a bill into Congress for the general use of the metric system by this country ten years after passage.
>
> An attempt was made several years ago to introduce the metric system in this country, but it was not successful. The American engineers rejected it.
>
> Aside from the fact that the metric system is based upon an unscientific premise and that in addition there is a miscalculation in the length of the meter itself, this system is foreign to the Anglo-Saxon race, being Roman (French) in its origin. It was an element in the French attempt to eradicate religion from the earth and to introduce a system of atheism. It is an infraction of the Mosaic system of measurement, which is definitely correlated to and preserved in the Anglo-Saxon inch. It is not recognized either in America or in Britain.
>
> It would seem that there are other methods besides physical occupation of territory in this hemisphere of attempting to attack and to violate the Monroe Doctrine, and the effort to introduce the metric system in this nation (America) is one of these "other" methods. It will not succeed, since God is keeping watch over His own. The eyes of all Americans should be wide open to these insidious attacks upon our institutions.
>
> "In God We Trust."

Its reading has made me sad. I have an inherited religious tendency and was brought up to have a feeling of reverence for sacred things. In fact I am actually a member of that Church now most vigorously urging the passage of more of our well-known "blue laws."

But now my conscience troubles me. Every time I have sat down before my chemical balance with its set of metric weights I have committed a sin in comparison with which kneeling before a heathen idol in a Chinese joss house would be a mere peccadillo. I must make a change in my manner of living. Instead of weighing out one gram of potassium iodide I shall hereafter weigh out $\frac{1000}{28350}$ of an ounce. I write this in fractional form for fear that perhaps even the mere use of the decimal point itself might be an infraction of the Monroe Doctrine, and I have reformed.

Little Falls, N. J. R. R. HENDERSON.

To Prevent Use of Industrial Alcohol as Intoxicating Beverage

To the Editor of Chemical & Metallurgical Engineering

SIR:—This office is very much interested in the matter of the use of denaturants or repellent substances which may be added to completely or specially denatured alcohol in order to guard against the accidental or willful use of such alcohols for intoxicating beverage purposes, particularly in shops and factories.

There are a number of reasons why it would be inexpedient to require the addition of the particular substance which you call attention to—that is fluoresceine—for this purpose. The color imparted on dilution of an alcoholic solution of this substance might be objectionable to a number of manufacturers who use completely denatured alcohol or some of the widely used special formulas, such as specially denatured alcohol formula 1 or formula 2-B.

The voluntary addition of fluoresceine to a factory stock of completely denatured alcohol or specially denatured alcohol where the fluoresceine itself is in nowise objectionable as an added ingredient would seem to be highly desirable. The dilution with water of the neutral or slightly alkaline solution of fluoresceine produces an intense yellowish-green fluorescence which is practically transparent with transmitted light but markedly opalescent with reflected light. When this solution is slightly acid, however, the dilution with water produces very little change.

The addition of any substance to a denatured alcohol that would cause, upon dilution to potable proof, a condition repellent to the eye is of considerable value in protecting the alcohol from possible beverage use.

Bureau of Internal Revenue, JOHN F. KRAMER,
Washington, D. C. Prohibition Commissioner.

Western Chemical & Metallurgical Field

Southern California Edison Co. Granted Permit for Colorado River Power Development

The Federal Power Commission has granted the application of the Southern California Edison Co. for a preliminary permit to develop 2,500,000 hp. from the waters of the Colorado River. This is one of the largest developments that have been contemplated under the new water-power bill.

Some of the possibilities of the project may be gathered from the fact that the area that may be served with power includes the entire states of Arizona, Nevada and Utah, more than half of Colorado and New Mexico and three-quarters of California, with additional areas in Idaho, Wyoming and Mexico. The total power that may be developed is estimated at 4,350,000 hp.; about three and a quarter million acres of land can be irrigated and over 400 miles of the river will be made navigable. The Colorado River is the second in the United States in size, having a drainage area of 250,000 square miles and an annual run-off of sixteen million acre-feet. It is proposed to build a storage basin holding about forty million acre-feet which will impound 93 per cent of the run-off. About 35 per cent of the power will be used for railroad electrification; the remainder will be available for agricultural and industrial uses.

Production of Metallic Tungsten at Keeler, Cal.

During the war the several tungsten mines near Bishop, Inyo Co., Cal., were comparatively heavy producers of scheelite, but the mines have been idle since the armistice. An estimate of the capital invested for mine development and milling machinery is $600,000. Some of those financially interested in the tungsten mines also have an interest in a soda ash plant on Owens Lake, about seventy-five miles from the mines at Bishop, and it was decided to experiment with the production of metallic tungsten, using soda ash and scheelite concentrates as the raw materials. A method has been developed by Cooper Shapley, general manager of the Round Valley tungsten mines, that produces a high-grade product at a very reasonable cost. An analysis of the metallic tungsten produced is:

	Per Cent		Per Cent
W	98.00	P	Trace
C	0.30	Cu	None
Fe	0.29	S	None
SiO_2	0.03	WO_3	None
Mo	1.25		

An experimental plant treating 25 lb. at a charge was built and an outline of the operation follows: The correct amount of trona, a crude soda gathered from the shores of Owens Lake at a cost of $3 per ton, is mixed with the scheelite concentrate in a ball mill, the batch transferred to a firebrick crucible and melted with crude oil fuel, the flame striking directly on the charge. When the melt is quiet, the charge is tapped, the molten material flowing directly into a small Pachuca tank nearly filled with water. The water is agitated violently by compressed air during the pouring of the charge and for an hour in addition. The action of the water on the molten sodium tungstate shatters this material so that it will all pass a 20-mesh screen and the sodium tungstate is easily and completely dissolved. The charge from the Pachuca is transferred to a redwood filter tank having a filtering medium of coco matting and canvas. The filtrate runs to storage tanks through a small filter press having filter paper between the plates. An absolutely clear solution results and, as the amount of insoluble matter is small, the press is cleaned only at rare intervals. The material in the filter tank is washed several times and the wash water returned to the Pachuca tank to be used for the next melt.

To precipitate an easily filterable tungstic oxide the solution is brought to boiling by means of steam coils placed directly in the solution and the boiling solution is transferred to stoneware crocks. The crocks are jacketed for hot water and contain enough hydrochloric acid to precipitate the tungsten as oxide. (About 3 per cent of nitric acid is used with the hydrochloric.) If the solution is kept nearly at the boiling point the precipitate will be comparatively coarse grained and easily filtered.

The precipitated material is allowed to stand for an hour at a temperature close to 100 deg. C., and the clear, weak acid solution decanted and replaced with distilled water obtained from the heating coils. The precipitate is run into a flat-bottomed filter tank having a filtering medium of coco mat and canvas (protected with shoveling strips) and is washed repeatedly with distilled water. An acid-free product results containing about 45 per cent water, as determined by heating a sample to 500 deg. C.

The batch is then transferred to a wooden mixer similar to a butter churn, and the correct amount of gas-house carbon is added to reduce the tungsten oxide to the metal. After kneading for half an hour the mixture is transferred to fireclay crucibles and allowed to dry slowly, waste heat from the reduction furnace being used to dry the product completely. Any reduction in volume due to shrinkage during drying is made up with more dry material, and the crucibles are covered with a graphite lid, ground to fit.

Reduction is done in a special furnace which is operated continuously and reduces a charge in about four hours' heating at 1,250 deg. C. Fuel oil is used for heating the furnace.

The metallic tungsten is a lumpy gray mass that must be ground and screened, and packed in 100-lb. tins.

Alunite Deposits of Utah

Increasing interest is being taken by Eastern capital in the alunite deposits of Utah. Several large concerns are doing important work in the state, while others are planning activity. One of the most recent important occurrences in Utah alunite history is the incorporation of the Utah Alunite Refining Co.

The company's holdings of eight claims are located in Sevier County, about 150 miles south of Salt Lake City and about one mile from Vaca station, on the Marysvale Branch of the Denver & Rio Grande R.R. Four products are obtained—potash alum, potassium sulphate, aluminum oxide and aluminum sulphate. It is stated that there is abundant water for milling purposes.

Iron: Nickel Alloys

Brief Description of the Properties of Nickel Steels and High-Nickel: Iron Alloys, the Former One of the Earliest Alloy Steels and Now of Widest Consumption, the Latter of Remarkable Thermal and Electrical Characteristics

BY PAUL D. MERICA
Superintendent of Research, International Nickel Co.

ALLOYS of nickel with iron, including nickel steels, are commercially by far the most important alloys of this metal, and the range of compositions used is a very wide one—from the alloys of low nickel content, the nickel steels, to those containing 30 per cent and more nickel. These alloys were first discovered in meteorites and have never ceased to interest and puzzle investigators because of the unusual properties of the alloys containing from 5 to 40 per cent nickel.

Binary alloys of all compositions solidify as solid solutions which upon cooling suffer both phase and magnetic transformations of great scientific interest and technical importance. The constitutional diagram[1] of the nickel: iron alloys is given in Fig. 1. Without entering upon a detailed discussion of the constitution of these alloys, for which further references[2] should be consulted, it is observed that the addition of nickel to iron and steel immediately depresses the temperature of both the A_2 and the A_3 transformation and in addition increases the temperature difference or lag between Ac_2 and Ar_2—i.e., the temperatures at which iron loses its magnetism upon heating and regains it upon cooling respectively. This temperature range between Ac_2 and Ar_2, within which the alloy may be either magnetic or non-magnetic depending on whether it has been heated or cooled to that range, is widened from practically zero for pure iron to about 500 deg. C. for an alloy containing 25 per cent of nickel; at the same time the magnetic transformation range is lowered to ordinary temperatures and below. With increasing nickel content the temperature range of magnetic transformation again rises and becomes quite narrow—i.e., there is little lag in the transformation on heating and cooling. Steels of the former group, containing from 3 to about 30 per cent nickel, have become known as irreversible steels, whereas those of higher nickel content are called reversible steels. Accompanying these magnetic changes which characterize reversible and irreversible steels are corresponding ones in other properties, such as thermal expansivity, elasticity, electrical resistivity, the thermal alterations of which are also reversible or irreversible depending on the composition.

The presence of carbon causes further complications in the properties and behavior of these alloys and will be considered only in connection with nickel steels of low nickel content.

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[1] *Compt. rend.*, 1899, vol. 128, p. 304, and Gulliver, "Metallic Alloys," p. 331.

[2] Guertler, "Handbuch der Metallographie." Arnold and Read, *Proc.*, Inst. Mech. Eng., 1914, p. 223. Mars, "Die Spezialstähle."

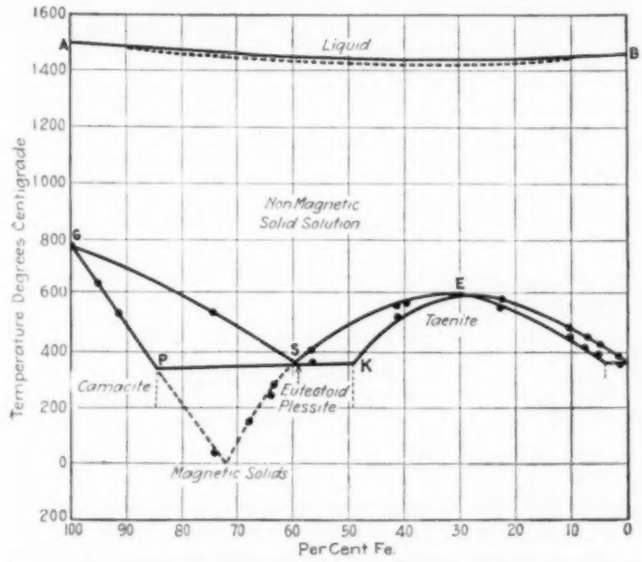

FIG. 1. EQUILIBRIUM DIAGRAM OF IRON: NICKEL ALLOYS

NICKEL STEELS

Nickel steel was the fourth alloy steel to be introduced and was first described in some detail by James Riley.[3] The general subject of nickel steels is too broad for anything but the merest sketch in this place and references should be consulted for further details.

The principal effects of the addition of nickel to steel are the following:

1. Nickel depresses the critical temperature ranges of steel, and according to the degree of such depression we may consider three groups of nickel steels—namely, pearlitic steels, which have normal transformation and heat-treatment or critical ranges and are similar to ordinary carbon steels in a general sense; martensitic steels, self-hardening but too brittle to be of any importance commercially; and austenitic steels, which are not susceptible to hardening by thermal treatment and may perhaps more properly be considered as ferronickel alloys containing carbon. The nickel and carbon content of the steel determines its inclusion in any one of the above groups; Fig. 2, according to Guillet, gives a classification of different compositions of nickel steels.

2. Nickel dissolves in the ferrite of steel and increases the hardness and strength without a corresponding loss of ductility. Thus Bullens[4] states that the addition of each 1 per cent (up to 5 per cent) of nickel to steel of forging grades will, without loss of ductility, increase the tensile strength and yield point from 4,000 to 6,000 lb. per sq.in., in the natural (not heat-treated) condition. But it is in the heat-treated condition that the superiority of nickel-containing steels is most evident and of most commercial importance. This is illustrated from the following data collected by the Society of Automo-

[3] *J. Iron Steel Inst.*, vol. 1, p. 45.

[4] "Steel and Its Heat Treatment."

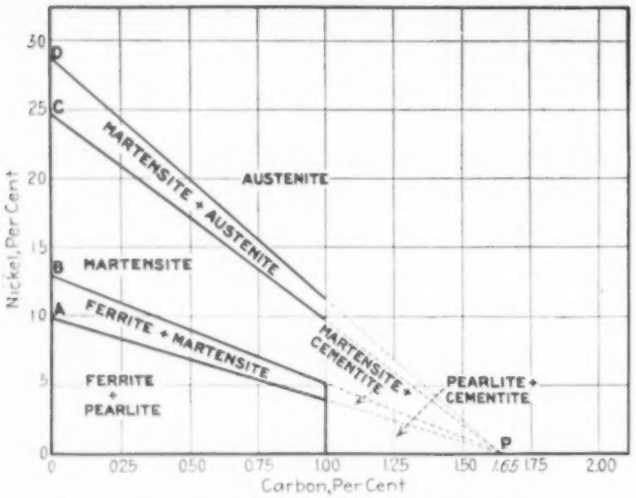

FIG. 2. CONSTITUTION OF SLOWLY-COOLED NICKEL STEELS (GUILLET)

tive Engineers showing a comparison between the tensile properties of a 0.40 per cent carbon steel without nickel and the same with 3.5 per cent of nickel in the heat-treated condition:

Analysis	Yield Point, Lb. per Sq.In.	Tensile Strength, Lb. per Sq.In.	Elongation in 2 In.	Reduction of Area
0.40 per cent carbon...	53,000	90,000	25	62.5
0.40 per cent carbon, 3.5 per cent nickel...	83,000	108,000	25	66

3. Nickel exerts an influence on the grain size of ferrite and pearlite, tending to produce a finer grain structure and finer pearlite, shading into sorbite. In the same sense it diminishes the rate of grain growth within the temperature ranges for heat-treatment, and thus minimizes the danger of overheating.

4. The structural effects of nickel noted above make a nickel steel (2 to 3½ per cent Ni, 0.10 to 0.20 per cent C) invaluable for case-hardening and superior to carbon steels in uniformity of zone of carburization and in mechanical properties of the core after heat-treatment.

The beneficial effects of nickel upon steel are intensified by the presence of other elements, particularly chromium; and chromium:nickel steels are perhaps more widely used today for heat-treated forgings for automobiles and other construction than are the straight nickel steels.

The following grades of steel are in most common commercial use:

(*a*) *Structural Steel With 3½ Per Cent Nickel:*

This is the oldest and best-known composition and constitutes the bulk of commercial nickel steel produced today. Its composition will average nickel, 3.0 to 3.5 per cent; carbon, 0.20 to 0.40 per cent. It is usually made in the open-hearth furnace and is used both in the rolled or forged condition and after heat-treatment.

It is much used for rolled structural shapes in construction of bridges and similar structures. It has also been used in the form of rails, although its economy for this purpose has not been satisfactorily demonstrated. In the heat-treated condition it is used for gun, engine and locomotive forgings, as well as for many automobile parts in too severe service for ordinary carbon steels. The average mechanical properties of this composition of steel after quenching in water from 1,400 deg. F. (760 deg. C.) and drawing at various temperatures are shown in Fig. 3.

(*b*) *Nickel: Chromium Steels for Heat-Treated Automobile and Other Forgings:*

These compositions constitute the most prominent group of "automobile" steels and are used for a great variety of parts and construction where high strength, toughness and ductility are required. Typical ranges of composition are given below:

	Chromium, per Cent	Nickel, per Cent	Carbon, per Cent
Low	0.5	1.5	0.20 to 0.50
Medium	0.5 to 1.5	1.5 to 3.5	0.20 to 0.50
High	1.5	3.5	0.40 to 0.50

The "low" and "medium" nickel: chromium steels are used primarily in the automobile industry for crankshafts, axles, driving shafts, spindles, bolts, etc., and for case-hardened pivot pins and cam rollers. The "high" nickel: chromium steels are used in the manufacture of heat-treated gears. The latter compositions are also the principal ones used in the manufacture of both armor plate and of armor-piercing projectiles. The mechanical properties of typical steels in the heat-treated condition are given in Figs. 4 and 5.

(*c*) *Nickel Steel for Case-Hardening:*

The principal properties of nickel steel which make it invaluable for case-hardening have been noted above; in addition there exists the possibility for high-nickel steels (nickel 5 to 7 per cent) of obtaining air-hardening or self-hardening case-hardened surface layers together with a tough pearlitic core. Typical compositions used for case-hardening are given below:

	Per Cent
Low nickel:	
Nickel	1.5 to 3.5
Carbon	0.10 to 0.20
High nickel:	
Nickel	5 to 7
Carbon	0.10 to 0.15

(*d*) *Mayari Steel From Cuban Ores:*

This is a natural alloy produced in the blast furnace and open-hearth furnace; it has been used principally in the form of rails and track bolts. Its composition averages nickel, 1.0 to 1.5 per cent; chromium, 0.20 to 0.70 per cent.

(*e*) *High-Nickel Steels:*

Such compositions as the following are termed perhaps more properly "ferronickel alloys": nickel, 25 to

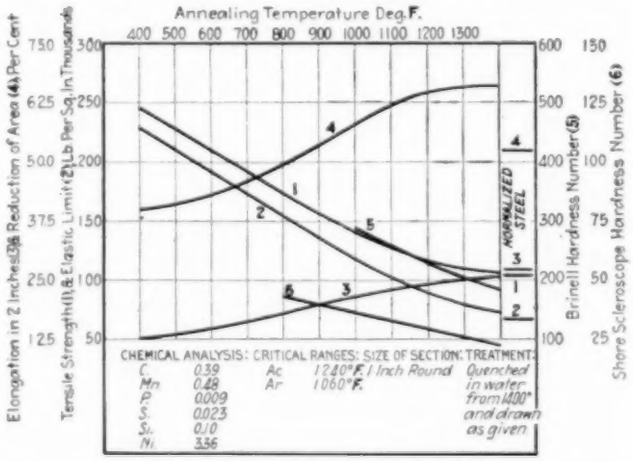
Annealing Temperature Deg. F.
400 500 600 700 800 900 1000 1100 1200 1300
Elongation in 2 Inches (3) & Reduction of Area (4), Per Cent
Tensile Strength (1) & Elastic Limit (2), Lb. Per Sq. In. Thousands
Brinell Hardness Number (5)
Shore Scleroscope Hardness Number (6)
NORMALIZED STEEL
CHEMICAL ANALYSIS: CRITICAL RANGES: SIZE OF SECTION: TREATMENT:
C 0.39 Ac 1240°F. 1 Inch Round Quenched in water from 1400° and drawn as given
Mn 0.48 Ar 1060°F.
P 0.009
S 0.023
Si 0.10
Ni 3.56

FIG. 3. PHYSICAL PROPERTIES OF 3½ PER CENT NICKEL STEEL FOR STRUCTURAL PURPOSES AFTER VARIOUS HEAT-TREATMENTS

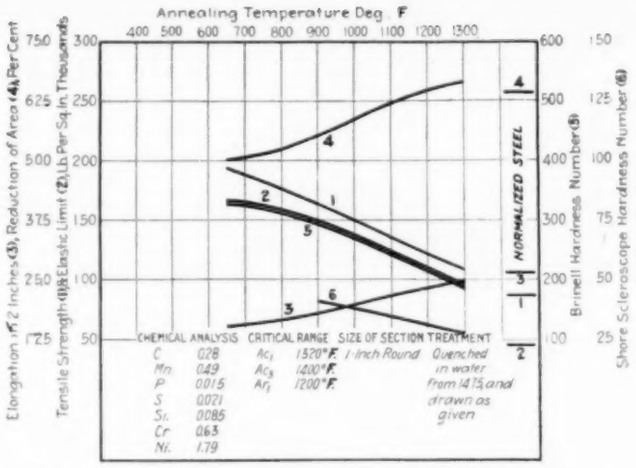

FIG. 4. PHYSICAL PROPERTIES OF A LOW NICKEL: CHROMIUM STEEL AFTER VARIOUS HEAT-TREATMENTS

40 per cent; carbon, 0.3 to 0.5 per cent. They are austenitic and do not respond to usual heat-treatments; they are, however, naturally quite tough and strong, have a low thermal expansivity and are very resistant to corrosion in air, fresh or sea water. They are much used for gas engines, valves and spindles, for ignition and boiler tubes, for valve stems on sea-water pumps. The alloys may be rolled and forged, but are not so readily machined as ordinary steel. They will have the following average tensile properties in the natural state:

	25 to 28 per Cent Nickel, 0.3 to 0.5 per Cent Carbon	30 to 35 per Cent Nickel	35 to 38 per Cent Nickel
Tensile strength	85,000 to 92,000	85,000 to 95,000	100,000 to 115,000
Yield point	35,000 to 50,000	40,000 to 50,000	64,000 to 78,000
Elongation in 2 in.	30 to 35 per cent	30 to 40 per cent	25 to 35 per cent
Reduction of area	50 to 60 per cent	40 to 60 per cent	50 per cent

The alloys containing about 25 per cent of nickel are much used for electrical resistance wire, in the construction of rheostats and electrical heaters. Table I gives values of the electrical resistivity[5] and its temperature coefficient[6] for binary alloys of nickel and iron.

The section given below on "Alloys for Electrical Purposes" contains further information on this application of the ferronickel alloys.

[5]Burgess and Aston, MET. & CHEM. ENG., vol. 8, p. 23 (1910).
[6]Guillaume, "Les applications des aciers au nickel."

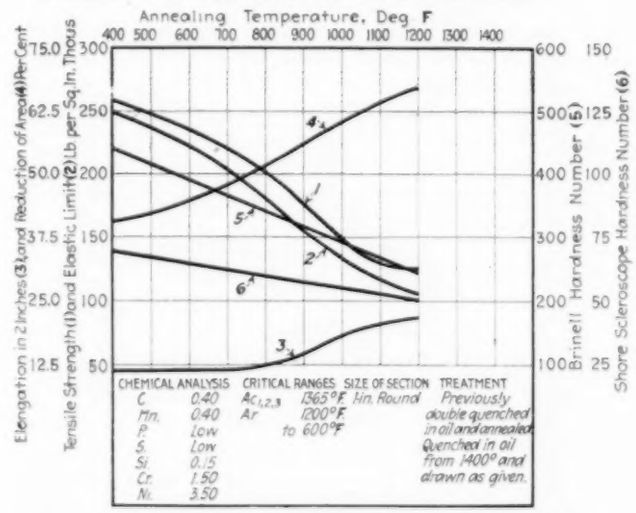
Annealing Temperature, Deg F
400 500 600 700 800 900 1000 1100 1200 1300 1400
Elongation in 2 Inches (3), and Reduction of Area (4), Per Cent
Tensile Strength (1) and Elastic Limit (2), Lb. per Sq. In. Thous
Brinell Hardness Number (5)
Shore Scleroscope Hardness Number (6)
CHEMICAL ANALYSIS
C 0.40
Mn 0.40
P Low
S Low
Si 0.15
Cr 1.50
Ni 3.50
CRITICAL RANGES
Ac1,2,3 1365°F.
Ar 1200°F. to 600°F.
SIZE OF SECTION
1/in. Round
TREATMENT
Previously double quenched in oil and annealed. Quenched in oil from 1400° and drawn as given.

FIG. 5. PHYSICAL PROPERTIES OF A HIGH NICKEL: CHROMIUM STEEL AFTER VARIOUS HEAT-TREATMENTS

TABLE I. ELECTRICAL RESISTIVITY OF NICKEL:IRON ALLOYS

Per Cent Nickel	Electrical Resistivity in Microhm-Cm.	Mean Coefficient of Resistivity Between 0 and t Deg. C.
0	12.1	.....
0.27	13.1	.....
0.56	15.4	.....
1.07	16.9	.....
1.93	16.4	.....
7.05	26.9	.....
8.17	26.7	.....
10.20	28.6	.....
11.29	29.4	.....
12.07	30.3	.....
13.11*	34.8	.....
19.21	36.2	.....
22.0+ 3 Cr.	.....	$(784-0.13t)10^{-6}$
22.11	38.7	.....
25.20	63.2	.....
26.2	.....	$(844+0.01t)10^{-6}$
26.40	65.5	.....
28.42	82.0	.....
28.7	.....	$(700-0.20t)10^{-6}$
30.4	.....	$(897-0.43t)10^{-6}$
35.0	.....	$(1,561-1.69t)10^{-6}$
35.09	81.1	.....
35.7	.....	$(1,161-1.68t)10^{-6}$
47.08	44.7	.....
75.06	22.1	.....
100.00	12.4	.....

* Contains 0.89 per cent C.

Within the range of compositions from 20 to 30 per cent nickel the ferronickel alloys may readily be obtained in a non-magnetic condition by cooling at normal

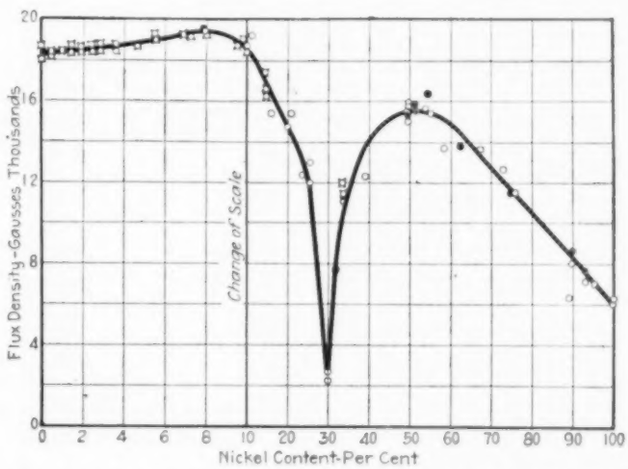

FIG. 6. MAGNETISM OF IRON: NICKEL ALLOYS (YENSEN)

rates from rolling or forging temperatures. They are used in this condition for the production of non-magnetic parts requiring strength and toughness. Table II shows the magnetic properties of ferronickel alloys.

TABLE II. THE MAGNETIC PROPERTIES OF NICKEL:IRON ALLOYS

Per Cent Nickel	Density D in G. per c.c.	Hegg 1910 (364) Transformation Temperatures, Centigrade (Curie Points) Heating Deg.	Hegg 1910 (364) Transformation Temperatures, Centigrade (Curie Points) Cooling Deg.	Saturation Values at 0 Deg. Absolute; Magnetic Moment per Unit Mass (B-H) σ_0	Saturation Values at 0 Deg. Absolute; Magnetic Moment per Unit Mass (B-H) $4\pi\sigma_0 D$	Curie Constants (Weiss & Foex 1911)
0	7.875	758	...	223.2	22,090	0.072
10	7.89	730	532	221.0	21,910	0.0577
20	8.02	625	218	210.8	21,340	0.0460
30	8.06	533	127	203.6	20,620	0.0315
40	7.63	365	...	184.2	17,660	0.0251
50	8.05	527	...	169.2	17,120	0.0227
60	8.29	599	...	146.8	15,290	0.0185
70	8.39	613	...	127.1	13,400	0.0157
80	8.52	562	...	103.1	11,040	0.0126
90	8.60	480	...	80.6	8,710	0.0100
100	8.86	374	...	58.8	6,550	0.0056

More recently Yensen[7] has made a thorough study of the electrical and magnetic properties of iron: nickel alloys prepared by melting *in vacuo*. In Figs. 6 and 7 are reproduced some of his typical results.

Beginning at about 25 per cent nickel, the thermal

[7]*Trans.*, Am. Inst. Mining Eng. (1920).

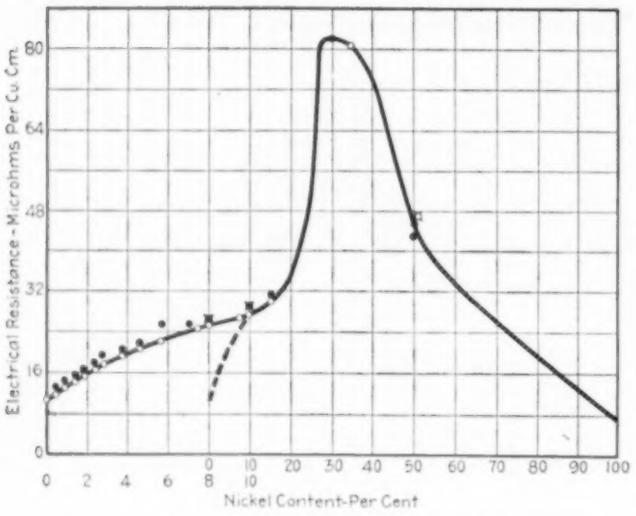

FIG. 7. ELECTRICAL RESISTANCE OF IRON: NICKEL ALLOYS (YENSEN)

expansivity of the ferronickel alloys at 20 deg. C. diminishes rapidly with increasing nickel content up to about 34 per cent; thereafter again increasing first rapidly and then more slowly to that of pure nickel. These curious changes are utilized in the manufacture of three patented alloys—invar, dilver and platinite—having respectively a thermal expansivity very low at ordinary temperature, nearly equal to that of glass and of platinum. Table III gives values of the thermal expansivity of ferronickel alloys.[6]

TABLE III. THERMAL EXPANSIVITY OF IRON:NICKEL ALLOYS

Per Cent Nickel	Mean Coefficients of Linear Expansion $\times 10^6$	Per Cent Nickel	Mean Coefficients of Linear Expansions $\times 10^6$
0	$10.354 + 0.00523t$	44.4	$8.508 - 0.00251t$
5.0	$10.529 + 0.00580t$	48.7	$9.901 - 0.00067t$
19.0	$11.427 + 0.00362t$	50.7	$9.824 + 0.00243t$
26.2	$13.103 + 0.02123t$	53.2	$10.045 + 0.00031t$
27.9	$11.288 + 0.02889t$	70.3	$11.890 + 0.00387t$
28.7	$10.387 + 0.03004t$	100.0	$12.661 + 0.00550t$
30.4	$4.570 + 0.01194t$	12.2 + 1 Cr	$11.714 + 0.00508t$
31.4	$3.395 + 0.00885t$	16.8 + 1 Cr	$11.436 + 0.00170t$
34.6	$1.373 + 0.00237t$	16.2 + 2.5 Cr	$19.496 + 0.00432t$
35.6	$0.877 + 0.00127t$	21.3 + 3 Cr	$18.180 + 0.00426t$
37.3	$3.457 - 0.00647t$	34.8 + 1.5 Cr	$3.580 - 0.00132t$
39.4	$5.357 - 0.00448t$	35.7 + 1.7 Cr	$3.373 + 0.00165t$
43.6	$7.992 - 0.00273t$	36.4 + 0.9 Cr	$4.433 - 0.00392$

Invar contains about 36 per cent of nickel and has a mean linear thermal expansivity of approximately 0.000,001 per deg. C. between 0 and 40 deg. C. It melts at 1,425 deg. C., has a density of 8.0 g. per c.c. and an electrical resistivity of about 80 microhm-cm. It is very resistant to corrosion in water and may be immersed in it for days without the appearance of rust spots. Platinite is quite similar except that it has a thermal expansivity equal to that of platinum (approximately 0.00,000,9 per deg. C.) and contains about 46 per cent of nickel. Dilver has a thermal expansivity coefficient of 0.00,000,8 per deg. C. Invar, as well as the other alloys of similar character and composition, may be rolled, drawn and machined and is used for the manufacture of measuring tapes, length standards, instruments and chronometers of high accuracy for which temperature-length changes must be almost wholly eliminated. These and similar alloys are produced now in this country. For further information concerning invar, circular 58 of the Bureau of Standards should be consulted. Perhaps the principal present use for platinite is for the sealing in wire of electric lights.

German Potash Production

According to figures furnished by the German Potash Syndicate the sales of potash salts in 1919 reached a total of 4,159,227 metric tons, with 812,002 tons of potash. In 1918 the sales of the Potash Syndicate amounted to 4,840,934 tons of potash salts, with 1,001,664 tons of potash, showing a falling off in 1919 of 681,707 tons of potash salts and 189,661 tons of potash. In 1919 the sales of potash were less by 192,279 tons than those of 1917 and 298,367 tons less than the sales in 1913.

Among the various potash salts only carnallite, 30 per cent manure salts and sulphate of potash show a fair increase in sales for 1919, the last named going to foreign countries for fertilizing tobacco, cane sugar, fruit trees and potatoes. All the other salts showed decreased sales.

The first post-war shipments to Great Britain, United States and other overseas countries began in July, 1919. From this date on the foreign sales showed an increase. The sales of potash in 1919 were marked by a falling off in the following countries and in the following amounts as compared with 1918: Austria-Hungary 34,307 tons, Belgium 21,204 tons, Russia and Poland 5,171 tons, Switzerland 5,074 tons and Luxumburg 1,357 tons. On the other hand, increases for the same years are shown in the cases of Holland and the Scandinavian countries. Furthermore there appear as purchasers for the first time after the war the following countries: The United States with 70,128 tons, Great Britain with 10,278 tons, Spain with 358 tons and the remaining American countries with 1,648 tons.

As a result of the renewal of trade relations between Germany and the former enemy countries the sales of German potash increased from 141,947 tons in 1918 to 174,968 tons in 1919, an increase of 33,022 tons. This increase would have been greater had not the purchases of countries like Austria-Hungary, Russia and Poland fallen heavily behind preceding years. A further handicap to increased sales in 1919 is traceable to the difficulties experienced during that year in effecting shipments overseas due to the scarcity of shipping space.

The most noticeable decrease in the sales of German potash is found in Germany itself with a decline of 222,683 tons, of which the amount of 212,917 was classed as for agricultural purposes. However, as Germany in 1913 took 536,102 tons of potash for agricultural purposes, as against 608,766 in 1919, the year 1919 still shows a gain over 1913 in this direction of 72,664 tons or around 15 per cent.

The following table is a general report of the Potash Syndicate's import and export business for the years 1913 and 1919:

	1913 Tons	1919 Tons
Inland	604,282	637,032
Export	506,076	174,962
Total	1,110,358	812,001

Coconut-Oil Mill Situation in the Dutch East Indies

In an analysis of the coconut-oil mill situation in the Dutch East Indies, Trade Commissioner John A. Fowler points to the advisability of American manufacturers of oil-milling machinery developing the market which arises from the growth of the industry in these islands. For full information request file FE-210, Bureau of Foreign and Domestic Commerce, Washington, D. C.

Armour Fertilizer Works—II

Svenska Den System of Acid Phosphate Manufacture—Acid Pumping and Storage—Phosphate Rock Mill —Mixing Raw Materials to Produce Fertilizers for Various Soils—Mechanical Operations and Apparatus Employed in the Complete Modern Fertilizer Plant*

By CHESTER H. JONES

FERTILIZER manufacture is carried on in the large building shown on the right in the above photograph and in the plan view Fig. 13. All raw materials except the acid are delivered from cars by way of the long platforms.

The operations consist of crushing and grinding phosphate rock, mixing ground rock with sulphuric acid to make acid phosphate, curing acid phosphate, removing hydrofluoric acid gas from the acid phosphate operation, accurately mixing and bagging other raw fertilizer materials. Electric current is distributed at 440 volts to the various motors in the plant through a large panel board located in the corner of the grinding room and so arranged as to meter the current consumed in the operation of each department. Trackage space for sixty cars is available, the tracks paralleling the shipping platform on both sides of the building.

The list of raw materials used in fertilizer blending are almost innumerable, but some of the more important ones are as follows:

Kainit from Europe. Potash content, 13 per cent.

Tobacco stems of high grade. Ammonia 3 per cent and potash 8.6 per cent.

Chilean nitrate.

Phosphate rock from the Columbia, Tenn., district with total P_2O_5 equivalent to bone phosphate of lime 72 per cent, iron oxide 2.8 per cent and Al_2O_3 2.8 per cent.

Sulphuric acid 53 deg. Bé.

Nebraska potash. K_2O content runs 20 to 30 per cent.

Muriate of potash from Europe. K_2O content is 50 per cent.

Tankage from the packing houses. Total P_2O_5 content is 9 per cent and ammonia runs 7 to 10 per cent.

Sulphate of ammonia. Ammonia 25 per cent.

Bone meal from Armour Glue Works. That known as 3-24 has 3 per cent ammonia and 24 per cent phosphoric acid; that called 2-27 has 2 per cent ammonia,

*For Part I see CHEM. & MET. ENG., vol. 24, No. 8, p. 333, Feb. 23, 1921.

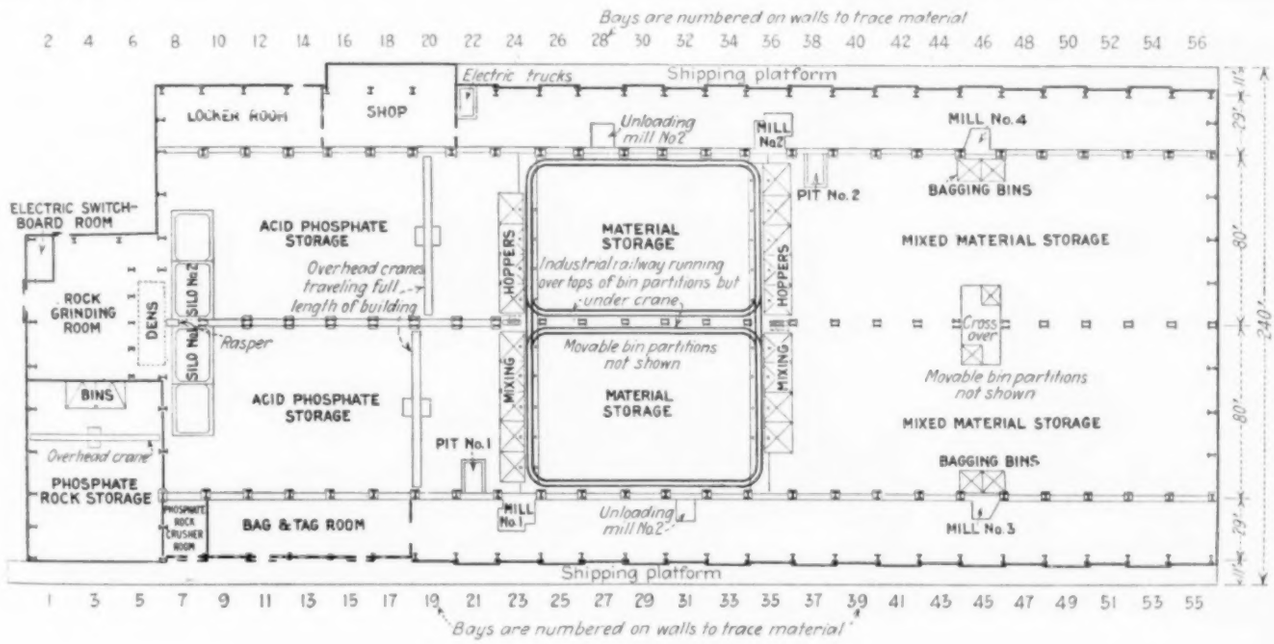

FIG. 13. PLAN OF FERTILIZER PLANT

27 per cent P_2O_5. Raw bone meal ammonia 4.5 per cent, total P_2O_5 22 per cent. Manure salt. K_2O 20 per cent. Cottonseed meal. Ammonia 7 per cent, available P_2O_5 2.5 per cent and K_2O 1.5 per cent. Dried blood from Armour packing houses. In considering the successful outcome of a fertilizer - manufacturing enterprise it is well to remember that packing concerns have a distinct advantage in that they have an assured source of organic and animal ammonia.

Acid Storage and Handling at Mill

The 2-in. pipe line from the acid plant runs across the yard to the corner of the rock-grinding room, where acid is distributed by two Chemical Equipment Co. pumps shown in Fig. 14. These pumps are so connected that acid may be delivered to the mill storage tank for acid phosphate manufacture either directly from the acid plant, from the storage tanks, shown in Fig. 15, or directly from tank cars. Acid may also be delivered from storage tanks to tank cars or *vice versa* or it may be pumped from acid plant to outside storage tanks.

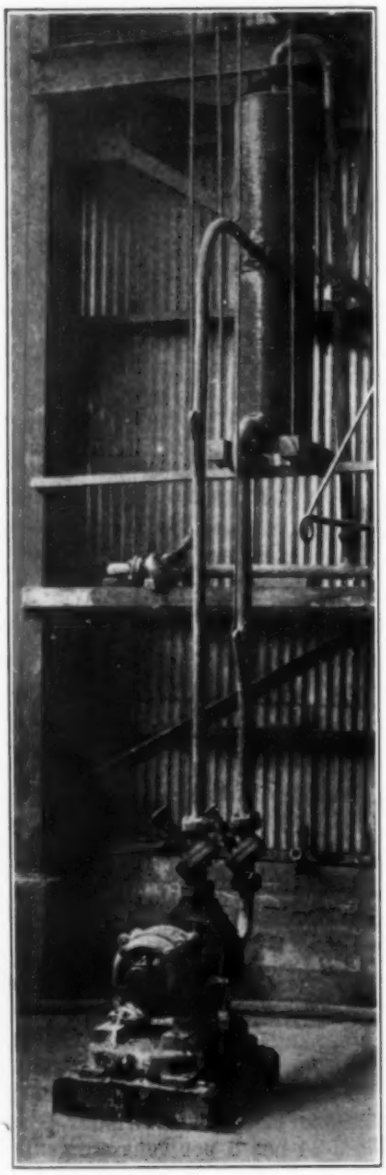

FIG. 14. ACID PUMPS AT FERTILIZER BUILDING

These tanks have no bottom outlet, but are emptied and filled through piping at the top. The centrifugal acid pumps accomplish the drawing up of the liquid from either tank cars or storage by means of the auxiliary priming tank shown in Fig. 14. The complete piping connections for this arrangement are shown in Fig. 16.

Engineers will realize that the lifting of liquids directly upward for a distance of 16 ft. where the pump intake is not flooded directly from the source of supply is an innovation in centrifugal pumping practice.

Rock Grinding

The phosphate rock is delivered from box cars to the crusher room shown near the lower left hand, Fig. 13, where it passes through a Valke & Murdock crusher system to produce ¾-in. size material and is delivered to the rock storage room. Storage capacity is about 3,500 tons.

The traveling crane delivers rock to overhead bins, which in turn feed to the grinding and pulverizing plant in the rock-grinding room. This department is equipped with one Raymond pulverizer and two Kent mills, all driven from a line shaft by a 200-hp. Allis-Chalmers motor. The rock is ground for 95 per cent to pass a 100-mesh screen and is delivered by elevators to the bins above the acid phosphate machinery. The material is handled through the mill system by screw conveyors and steel elevators made by the Weller Mfg. Co. Between 125 and 150 tons of rock are ground every twenty-four hours.

Acid Phosphate Manufacture

The Svenska Den system for making acid phosphate was brought over from Sweden in 1911, the Armour company purchasing both patents and machinery from the original owners. It has been in operation in a great many of the Armour plants since that time. While the methods of handling the material, particularly the operation involving the pushing of a den full of the newly mixed phosphate against the cutting apparatus, may seem unwieldy, nevertheless the system is efficient in actual operation. It is necessary for the green phosphate to cure over a considerable period and the action in the dens has a certain beneficial effect toward this process.

A glance at Fig. 13 will locate the machinery adjacent to the rock-grinding room with the two dens in dotted outline and the four silos adjoining. Fig. 17, a side elevation taken from the rock-grinding room, gives an excellent idea of the arrangement of the duplicate system of machinery, and Fig. 18 is an elevation of the left end of Fig. 17.

The pulverized rock elevator appears in the center of Fig. 17, delivering the product through a butterfly

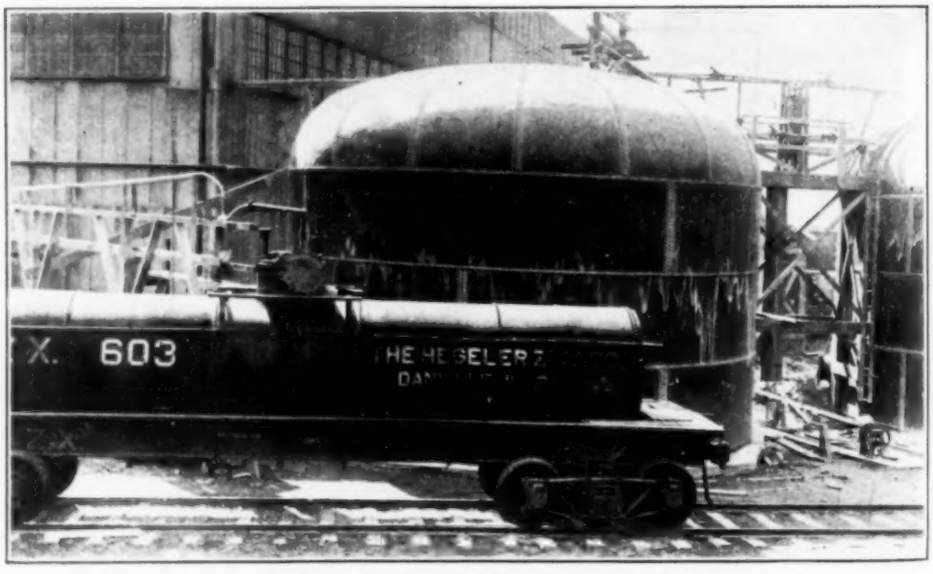

FIG. 15. ACID STORAGE AND PIPING

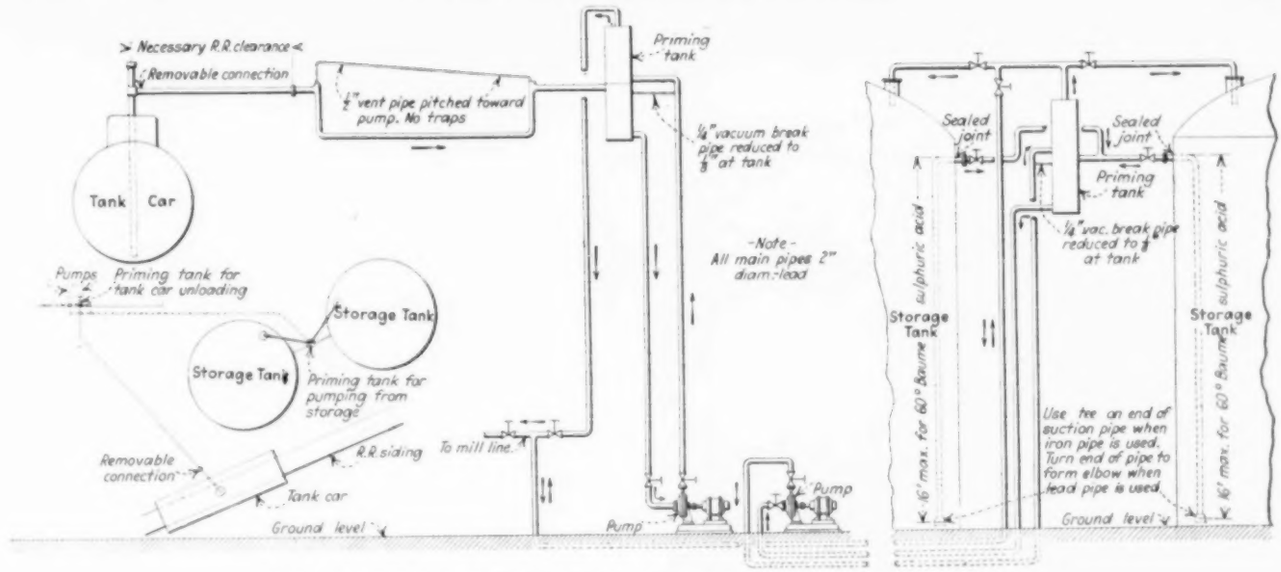
Necessary R.R. clearance
Removable connection
½" vent pipe pitched toward pump. No traps
Priming tank
¼" vacuum break pipe reduced to ⅛" at tank
Tank Car
-Note-
All main pipes 2" diam.-lead
Pumps
Priming tank for tank car unloading
Storage Tank
Storage Tank
Priming tank for pumping from storage
Removable connection
R.R. siding
To mill line
Tank car
Ground level
Pump
Pump
Sealed joint
Sealed joint
Priming tank
¼" vac. break pipe reduced to ⅛" at tank
Storage Tank
Storage Tank
16' max. for 60° Baumé sulphuric acid
16' max. for 60° Baumé sulphuric acid
Use tee on end of suction pipe when iron pipe is used. Turn end of pipe to form elbow when lead pipe is used.
Ground level

FIG. 16. PLAN AND ELEVATION OF ACID-HANDLING CONNECTIONS

valve on the third floor to the screw conveyors of either unit, whence it is carried to the dust weigh hopper over the mixers on the second floor. The acid 53 deg. Bé. sulphuric acid is simultaneously drawn to the acid-measuring hopper from the tank on the third floor.

Each charge for the Steadman pan mixer consists of about 1,625 lb. of acid, basis of 50 deg. Bé., and a like quantity of ground rock, or about 1½ tons total charge to the batch. Considerable quantities of fume are developed in the mixing and subsequent operations which is principally produced from the action of the sulphuric acid upon the fluorspar in the rock giving off hydrofluoric acid and silicon fluoride. This is conducted through tarred wooden flues to a wood stave tower

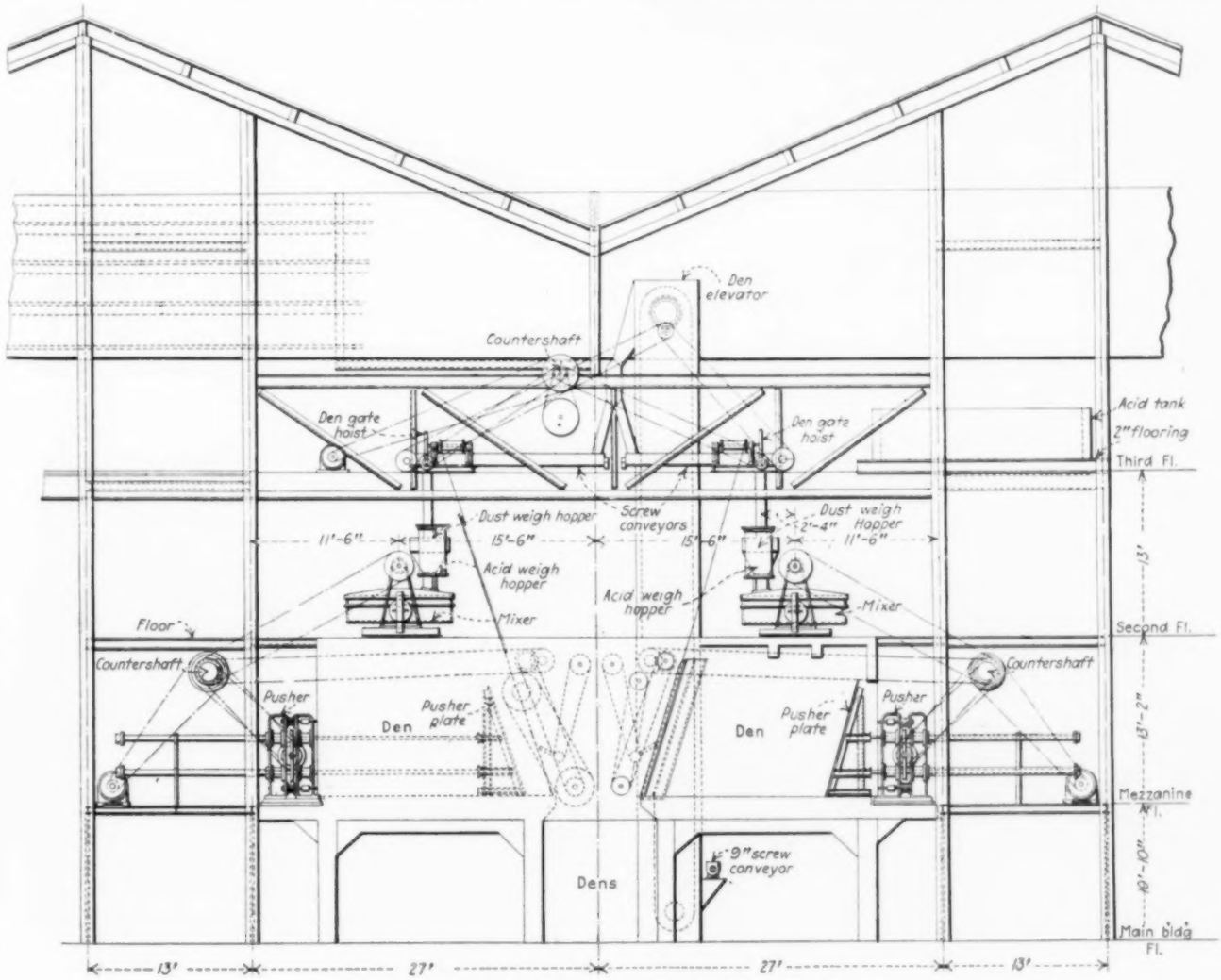

FIG. 17. SIDE ELEVATION, ACID PHOSPHATE PLANT

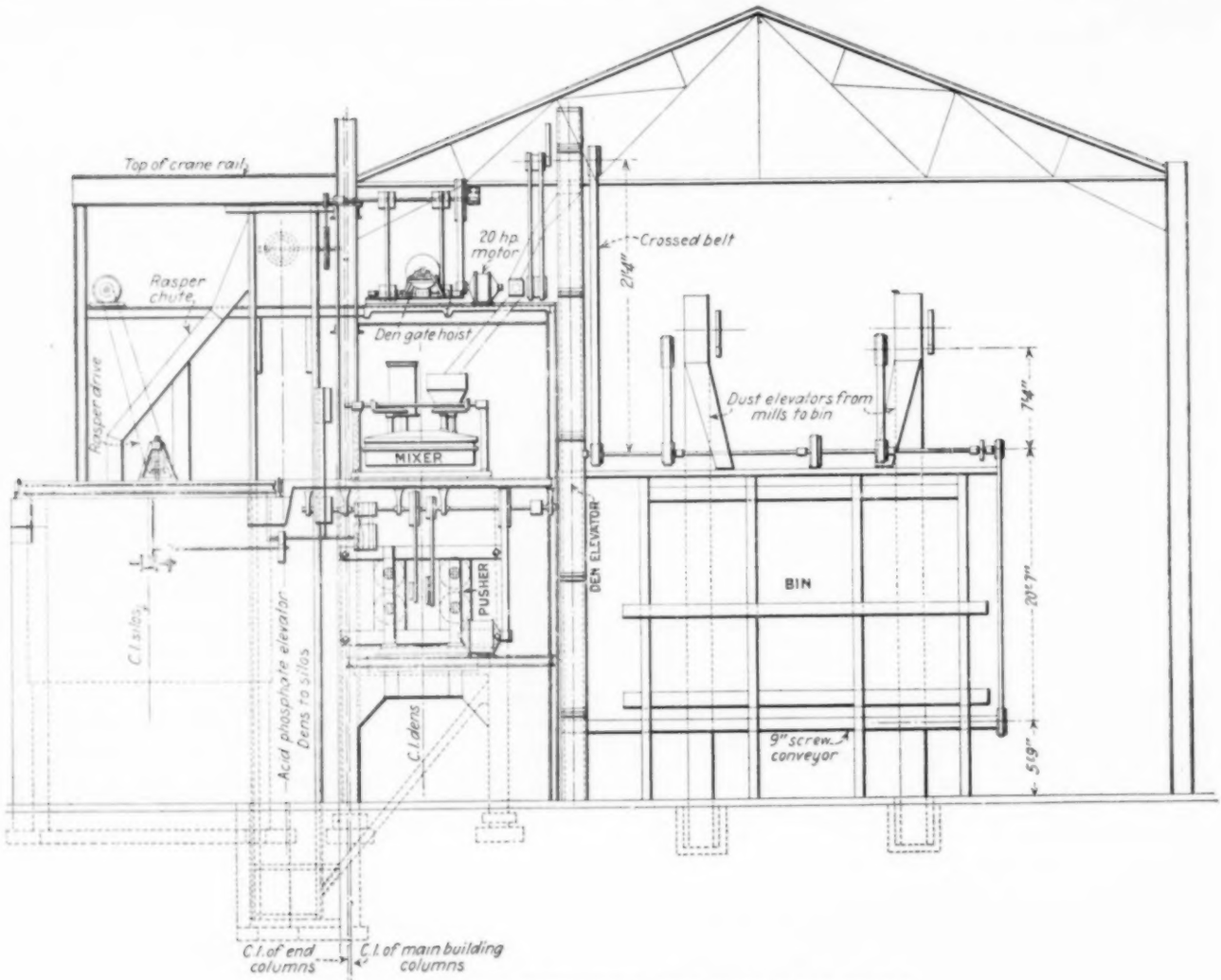

FIG. 18. LEFT END ELEVATION, ACID PHOSPHATE PLANT

system outside of the building and absorbed in water. The exhauster on the end of the line is also made from wood.

Figs. 19 and 20 show the Steadman mixers and connections for feed and fume removal. The floor in the foreground of Fig. 20 is the movable platform over silo 1, as will be later noted.

When the batch is finished the mixer is discharged to the den directly below. One den is charged while the other is discharging.

The dens are constructed of heavily reinforced concrete on the side walls and bottom and will hold about 40 tons of acid phosphate. On the rear end wall of each den is located the pusher plate, actuated by the pusher mechanism. The position of pusher plate shown on the right hand of Fig. 17, mezzanine floor, is maintained while the den is being filled from the mixer above. The front end wall consists of a movable steel plate set at an angle, as also shown, on the same den, completely closing the opening during the charging.

FIG. 19. STEADMAN MIXER, SHOWING WOODEN FUME LINE

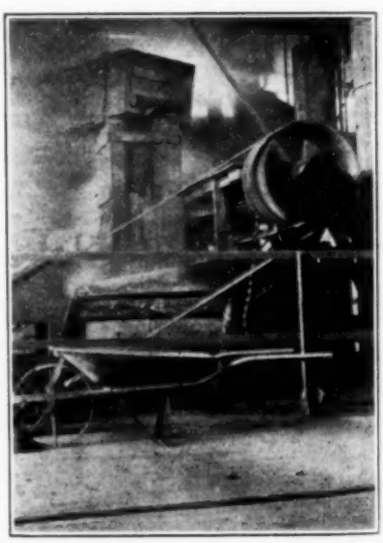

FIG. 20. MIXER IN OPERATION, SHOWING DRIVE

As soon as the den is completely filled this steel door is elevated out of the way by the drum gate hoist on the third floor and the den is ready for discharging. The cutting mechanism is next thrown into operation. This consists of steel link belts equipped with large cut-

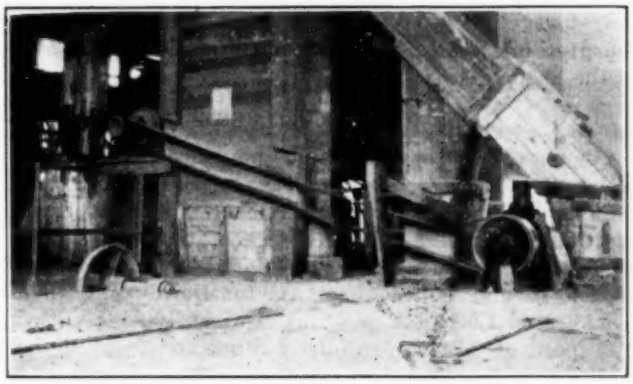

FIG. 21. RASPER AND DRIVE

ting wires, the whole covering the face of the material as exposed by the raising of the steel gate. This mechanism is indicated in dotted outline as belts running at approximately the same angle as the gates.

Simultaneously with the starting of the cutters, the pusher motors are thrown in and the pusher plate slowly moves forward, forcing the whole mass of material against the cutters as fast as they can operate to shave it away at the surface.

Left-hand den, Fig. 17, shows position of pusher plate when den is nearly discharged. The machinery which operates the pusher plate consists of four large threaded bars with driving nuts working on the order of a screw-jack. A rear view of the plate mechanism is shown in Fig. 18.

As the cutters shave away the wet packed material to a powder it falls into the boot of the acid phosphate

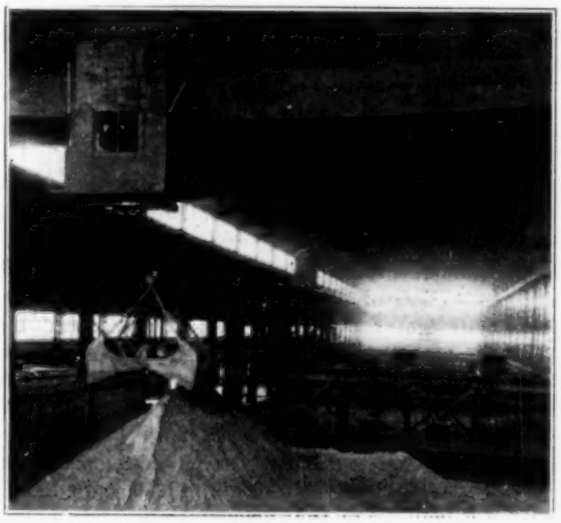

FIG. 22. CRANE HANDLING ACID PHOSPHATE TO STORAGE PILE

elevator, Fig. 18, whence it is delivered to the rasper chute.

RASPING AND AIRING

The rasper receives the damp phosphate and puts it through a further intimate mixing operation in much the same manner as the den cutters. The chute and rasper drive are shown in Fig. 21. The rasper is located between silos 1 and 2 as indicated in Fig. 13, and may be discharged to either silo. It will be noted on the left of drawing, Fig. 18, that each silo is covered by a movable platform while being filled. This forms a closed compartment from which the fumes and dust are drawn to outside atmosphere by a Sturtevant exhauster during the operation. The platform appears in the foreground, Fig. 21, one of the supporting car wheels showing on the left. When a silo has been filled the platform is moved away by motor drive and the material is removed to the curing piles in acid phosphate storage by overhead crane. Here it remains at least six weeks before shipment. About 50,000 tons is produced annually at the present time.

Fig. 22 is a view down one side of the fertilizer mixing plant from the silo platform with one of the two Champion 10-ton cranes delivering phosphate to the curing piles in storage. Fig. 23 shows a closer view in the

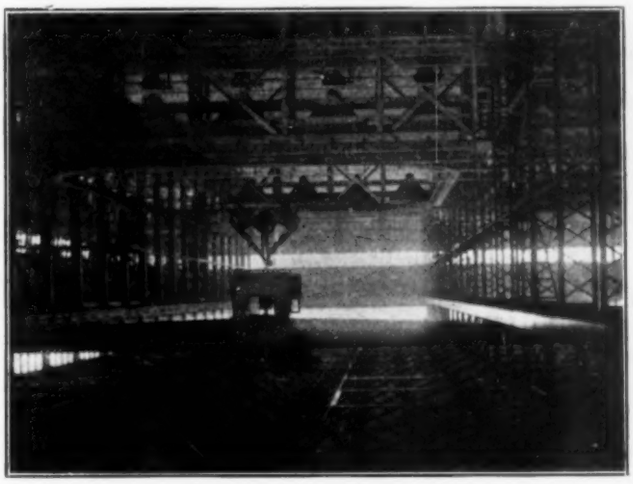

FIG. 23. MIXING PLANT

same direction with the crane in position to discharge a load to the mixing bins. Note industrial railway running along tops of bins and the two cars, Fig. 22.

MIXING FERTILIZER

The general layout of operations here differs from the usual principle of having the straight line flow of materials through the plant in that the work is carried out in three dimensions.

The crane is the key to the situation in that it both fills and empties stock piles from the top. The partitions or bulkheads for separating the various stock piles are made up from 2 x 10-in. timbers laid flat and spaced with 2 x 4's on edge. (See Fig. 24.) This new system of bulkheading secures better ventilation of the piles and allows ready alteration in partition arrangements to suit changing conditions and quantities of materials. When it is desired to mix up a certain fertilizer the crane man is handed an approximate weight formula and proceeds to gather the ma-

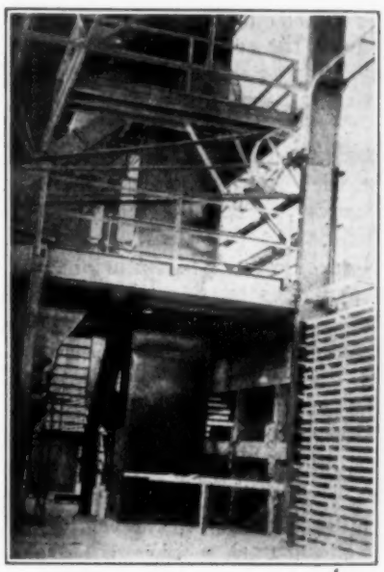

FIG. 24. BAGGING MILL 3

terials from the stock piles in the material storage area, dropping them into the tops of the mixing bins as shown in Fig. 23, one kind of material to each bin. Some material is also delivered by the industrial railway. Directly below each bin is located a Standard Scale & Supply Co. hopper scale, into which the material is drawn to accurate weight. These scale hoppers discharge at the bottom onto a 36-in. belt conveyor running beneath the whole battery of scales and delivering material to mills 1 and 2. (See Fig. 13.) When the determined quantities have been weighed into scale hoppers they are simultaneously released on signal, to secure a preliminary mixing on the belt. Entering the elevator boot at mill 1, mixed material is delivered to the Steadman shaker screens on the upper balcony (Fig. 25.) The fine material goes through to the mixing hopper shown suspended from the second balcony. The reject from the screen goes through the squirrel cage disintegrator, seen as a large revolving cylinder on the first balcony, and thence is returned to the shaker screen.

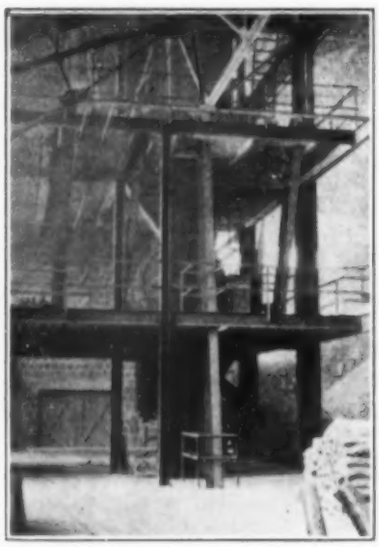

FIG. 25. MILL 1

Mixing the Fertilizer and Bagging the Finished Material

When the charge is completely screened and delivered to the mixing hopper it is released into the Steadman pan mixer. Here it is held until thoroughly mixed. This is the most important operation in the production of mixed fertilizers. The mixer discharges to the three bagging hoppers on the main floor. The finished material may either be bagged at the hoppers or returned to the floor as shown through the chute on the lower right. Here it is again picked up by the crane and conveyed to mixed material storage. The bagging mill is manufactured by the Atlanta Utility Works and is equipped with automatic scales.

Unloading mills 1 and 2 are simply elevator arrangements for receiving material from piles dumped into the boots by crane and conveying it to the cars on the industrial railway overhead.

Bagging mills 3 and 4 receive finished material from the mixed fertilizer storage piles by way of the crane and wooden bagging bins. These empty into an elevator hopper which feeds a shaker screen through inclined chute, upper left, Fig. 24. It passes downward through the shaker screen to the steel hopper directly below. Thence it is drawn off through the two bagging hoppers equipped with Sturtevant automatic scales.

The bagged fertilizers are stacked along the floors on each side of the building immediately accessible to the shipping platform. Elwell-Parker storage battery trucks are used for conveying the bagged material about the storage and shipping platforms. Equipment for charging and maintaining the batteries is located next to the shop, Fig. 13.

Auxiliary Equipments

Completely equipped machine shop, electricians' shop, tool room and locker wash rooms for white and colored force are maintained in the fertilizer building. Every provision is made for taking care of the men. About 60 per cent of the personnel is colored labor. Fire protection is maintained by a Dayton-Dowd centrifugal pump rated 1,000 gal. per min. against 100 lb., with a full speed of 1,750 r.p.m. direct-connected to a 100-hp. 1,740 r.p.m. Northwestern Mfg. Co. motor, drawing its supply of water from a 200,000-gal. concrete reservoir.

The chemical laboratory occupies the top floor of the brick office building and is well equipped for both research and control work. Ten chemists make up the present staff.

Conclusion

Manufacturing plants, like men, have character, but the character of any plant is only a physical manifestation of the sum of human characters who carry on the daily operations. The designers, it is true, are responsible for the mechanical beauty of the process in all that the word means to the heart of an engineer, but the operators may mar or enhance its being. They alone are responsible for its becoming a marvelous living thing. If they do not put into the work that something we call morale or spirit, the total effect on the visitor is more depressing than an overgrown graveyard.

Those engineers who are privileged to observe the character of procedure of the Armour Fertilizer Works organization at Chicago Heights carry away an inspiration from both an æsthetic and economic viewpoint. The chemical engineers lay down alike the immediate and the new lines of work to follow and the common sense human touch carries it through.

Crisis in Swedish Tar Industry

The Swedish tar industry, which during the war reached considerable proportions, seems to be facing ruin, reports Consul Walter H. Sholes, of Goteberg. Of the about 900 factories of the country, not more than 100 are working, and these few are working under unfavorable conditions. Good wood tar, which before the war was sold at 30 to 35 ore per kilo (7.8 to 9.1c. per 2.2 lb.) now brings only 15 ore (3.9c.), while manufacturing expenses are estimated to be double. Factory owners have been forced to the unusual expedient of asking for a loan from the government. It is possible that this will appear before the coming Riksdag.

Production of Castor Beans in Java

Castor-bean production is now encouraged in Java, states an issue of Holland's *East India*, the oil being already used by the natives, especially for the Battik textile industry. It has been found that the seed can be safely grown under copra trees, the yield per acre adding considerably to the native's profit on the copra. During the first half of 1920 exports of castor beans from Java amounted to 742,000 kilos (kilo equals 2.2 lb.), against 301,000 kilos for the corresponding period of 1919 and only 99,000 kilos during the first six months of 1918.

Macroscopic Examination of Metals

A Brief Statement of the Defects Which May Be Revealed by Visual Examination of Etched Smooth Surfaces of Steel and Other Alloys—Physical Unsoundness and Internal Strain May Be Detected by Special Methods

By HENRY S. RAWDON
Physicist, Bureau of Standards

THE term "structure," when employed with reference to metals and alloys, is used in a somewhat restricted sense. The metal microscopist ordinarily does not include in his definition of this term such characteristics as the minute crystalline structure, the arrangement of atoms and such other fundamental features of the structure of matter as may be revealed by suitably refined means. The term is used to include those features for which no refinement greater than that to reveal which the modern compound microscope is necessary. It should be borne in mind, however, that in a few special cases recourse must be had to very special means for suitably revealing the structural features of the metal.

Macroscopic Examination

The study of the structure of any metal most properly begins with the macroscopic examination of the specimen—that is, with an examination which does not involve any magnification other than that obtained by the use of the simple magnifier. Although this survey is usually made for the purpose of revealing chemical non-homogeneity, generally by some suitable etching method, other important structural features are often revealed. The various features revealed by the macroscopic examination of metals may be summarized under the following types:

1. Chemical non-homogeneity, due to segregation, liquation, decarburization, cementation and similar causes. In wrought metals, lack of complete chemical homogeneity often serves the useful purpose of furnishing a record of the plastic flow of the metal during the various manufacturing operations. This is generally revealed by etching.
2. Crystalline heterogeneity due to rate of cooling and to local variations in the cooling. Local overheating may also contribute to this. Etching with ammonium persulphate is admirable for both steel and copper alloys.
3. Mechanical non-uniformity; presence of internal stresses. When the condition is very severe it may be revealed by deep etching with mercury solutions for copper alloys and concentrated acids for steels.
4. Physical unsoundness, blowholes, porosity, "flakes," internal discontinuities, etc. X-ray and the magnetic examination in addition to visual examination may be used to show such features.

Chemical Non-Homogeneity and Crystalline Heterogeneity

One of the most serious and most common of the defects of alloys revealed by macroscopic examination is the lack of chemical homogeneity. Such variations in composition may be brought about in the material intentionally as, for examples, in case-hardened steels, partially malleableized cast iron, and similar products, in which case it is hardly to be classed as a defect. In the greater number of examples by far, however, chemical non-homogeneity represents an undesirable state resulting from conditions of manufacture, such as segregation and liquation. Such conditions often are so pronounced that they persist in the metal throughout the different treatments, both mechanical and thermal, that it received and so appear in the metal in its finished state. They may thus serve the useful purpose of furnishing a record of the plastic flow of the metal during the various manufacturing operations. Variations in the chemical composition of any alloy quite generally result in a differential attack of the material when it is subjected to the action of a corrosive or etching reagent of any kind. The greater the difference in composition in different portions of the metal the more pronounced are the relative differences in the etch-pattern which results.

General Method of Using Reagents

Table I gives the more commonly used etching reagents for macroscopic examination of steel. Precautions in the manipulation may be as follows:

The specimen, which has been sectioned and roughly polished, carefully cleaned free from oil marks or fingerprints by washing in alcohol or gasoline and then dried, is immersed in the solution, polished surface up. Care must be taken that the solution quickly covers the entire surface, that no air bubbles are entrapped and that the liquid is agitated gently; otherwise queer misleading markings on the etched surface may result. If desired, the surface of the metal may be rubbed with a little emery flour on the tip of the finger washed with water and immersed while still wet so as to promote the even flow of the etching reagent over it.

Etch patterns produced by a prolonged attack by a dilute acid are often much less sharp and distinct than one produced in the same material by a rapid attack by a concentrated acid. A prolonged etching—for example, four or five hours—in 5 per cent alcoholic solution of picric acid is often very useful, however. The deeply etched specimen may be used for producing a permanent record by inking the face with printer's ink and making a print on paper.

Sulphur-Printing

The distribution of sulphur is usually shown by the so-called sulphur-print method. The steel specimen is sectioned and the surface, after being smoothed off with a file, is pressed firmly against a sheet of photographic paper which has been moistened with a dilute sulphuric acid solution. Two c.c. concentrated acid in 100 c.c. water is the concentration generally used, though in many cases a more dilute one may be used to advantage. Particularly is this the case with metal very high in sulphur and also for very large specimens where considerable time is needed for placing the paper in

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TABLE I COMMON ETCHING REAGENTS FOR STEEL MACROSTRUCTURE

Name	Composition	Special Manipulation	Remarks
Heyn's	10 g. $CuCl_2$, 2 NH_4Cl + 2H_2O in 120 c.c. water	Copper film removed by wet cotton swab	
Iodine	10 g. I, 20 g. KI, 100 c.c. water		Markings not so clear as with Heyn's.
Concentrated acids	Conc. HCl Conc. HNO_3 in equal parts water	At 100 deg. C	
Ammonium persulphate	20 c.c. conc. H_2SO_4 in 100 c.c. water 1 or 2 g. $(NH_4)_2S_2O_8$ in 10 c.c. water	Often used at 40 deg. C	Excellent for crystalline heterogeneity. Also for copper alloys.
Mercuric chloride	10 g. $HgCl_2$, 20 c.c. 1.12 HCl, 100 c.c. water	Dip thin silk in reagent and spread silk over metal	
Stead's	10 g. $CuCl_2$, 40 g. $MgCl_2$, 20 c.c. conc. HCl; alcohol to make 1,000 c.c.		
Le Chatelier	100 c.c. 95 per cent alcohol, 10 c.c. water, 1 g. $CuCl_2$; 0.5 g. picric acid; 1 to 3 c.c. conc. HCl		

position. "Matt-finish" paper should be used. It is extremely difficult to prevent glossy paper from slipping on the metal surface, in which case a blurred print results. A fine polish of the surface such as is essential for microscopic examination is not necessary nor desirable for sulphur-printing. Very clear prints can be made on surfaces finished with a medium-fine file. Bromide paper or any of the common developing photographic papers may be used. By the use of a suitable press, prints which are as clear and definite as the photographs of the etched surfaces may be obtained.

The work of Le Chatelier and Bogitch[1] indicates that the darkening of the sensitized surface of the photographic paper is due to the action of the acid upon the sulphur alone and not to the combined action of sulphur and phosphorus, as was formerly generally supposed. The assumption is always made, however, that any non-homogeneity which may exist for the other metalloids, besides sulphur, occurs under the same conditions as does that of sulphur and that the distribution of sulphur recorded in the sulphur-print is an index of the distribution of the other constituents of the steel also.

For revealing the macrostructural features of brasses, bronzes and similar alloys of high copper content, an aqueous solution of ammonium persulphate is very often employed, although an acidified solution of ferric chloride or an ammoniacal solution of copper chloride may be used with very good results. The relative size and arrangement of the crystals are the features in which one is most interested—that is, in addition to the matter of soundness in the case of castings. In this case, however, an etching is usually unnecessary.

The reagent commonly employed for etching aluminum and its alloys for revealing the macrostructure is an aqueous solution of sodium hydroxide (approximately 10 per cent). It is customary to heat the specimen in the solution until the surface is sufficiently etched. A combination of alkali and hydrofluoric acid etching has been highly recommended by Carpenter.[2] The specimen is etched in an alcoholic solution of sodium hydroxide to remove the "flowed" surface metal. When the surface has been faintly etched, the sample is transferred to a dilute aqueous hydrofluoric acid solution (1 or 2 per cent) and allowed to remain until the etching is complete.

The occurrence of minute pores or intercrystalline cavities in castings of light aluminum alloys is a matter of grave importance. Their presence can often be detected in suspected metal by immersing a polished specimen in alcohol colored with picric acid or some other brightly colored dye. The specimen, after rapid washing to remove all traces of the dye on the surface, is dried and allowed to stand in a warm place. The porosity of the metal is often indicated by the appearance of colored spots on the surface as the colored alcohol evaporates from within the internal cavities in which it was inclosed.

[1] H. Le Chatelier and B. Bogitch, "Macrographie des Aciers," *Rev. Met.* vol. 16, p. 129, 1919; CHEM. & MET., vol. 23, p. 383, Sept. 1, 1920.

[2] H. C. H. Carpenter and C. F. Elam, "Crystal Growth and Recrystallization in Metals," *J. Inst. Metals*, vol. 24, 1920.

PHYSICAL UNSOUNDNESS

Much of the evidence of this phase of the structure of metals is furnished by a simple visual examination. In case the unsoundness is of a minute character, the method described for aluminum may be used. In other cases very special means must be used. If the surface of the specimen is carefully machined, a very light finishing out with a very sharp tool being made, evidence as to the *true* state of the soundness of material is often made available—information can be obtained in almost no other way. The ordinary methods which involve polishing and etching exaggerate the features of unsoundness to a considerable degree. In many alloys and metals which are rather coarsely crystalline careful machining is often sufficient also to reveal the structure of the material to a very surprising degree.

An examination by means of X-rays is often of value if the specimen is not too large. The features revealed by this method of examination are primarily those

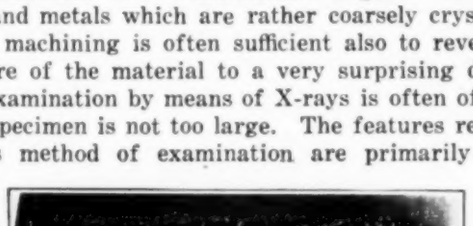


FIG. 1. SECTION OF A 1-IN. MANGANESE BRONZE ROD ETCHED WITH AN ACIDULATED AQUEOUS SOLUTION OF MERCUROUS NITRATE. × 1

which result from considerable differences in density, hence it is of great value in locating internal cavities and similar flaws. Ordinary segregation cannot be revealed by this means, although it has been successfully used in detecting such features of composition as resulted from the addition of a lead alloy for filling cavities in light aluminum castings. Specimens of steel to be examined by this means should not exceed ½ in. in thickness. As a general rule, the thicker the specimen the more pronounced must be the defect in order that its presence can be revealed by this means.

For the detection of surface cracks such as may be produced by hardening by quenching and similar operations upon steel, a magnetic method will be found very useful. The method is particularly valuable for

revealing them in an early stage in the shaping of a piece—for example, precision gages and similar pieces which must be ground to size—so that defective specimens may be discarded without much expenditure of wasted effort. The roughly polished specimen is magnetized and then immersed in a light oil containing very fine iron dust in suspension. Kerosene and "cast-iron mud" such as is obtained from lapping disks may be used.

The iron particles bridge across any slight discontinuity in the surface of the specimen and locate very accurately the system of surface cracks. The excess of iron dust may be removed by bathing the specimen in alcohol or clean kerosene. The method has also been successfully used for the detection of internal fractures in wrought steel parts.[3]

Mechanical Non-Uniformity

The examination of metals for mechanical non-uniformity—i.e., for the presence of internal stresses of high magnitude which may later lead to serious deterioration—may be noted here. Fig. 1 shows a portion of a cold-worked rod of manganese bronze which

FIG. 2. HARDENED STEEL BALLS WHICH SPLIT OPEN WHEN DEEPLY ETCHED WITH CONCENTRATED HYDROCHLORIC ACID. × 2

has been immersed in a solution of mercurous nitrate acidulated with nitric acid. The cracks which were formed by the action of this reagent may be taken as an indication of what would undoubtedly have occurred spontaneously later in service.[4] Materials which crack readily when treated in this manner can be shown by other means to be highly stressed internally, as has been described at length elsewhere.[5]

Steel parts such as balls and roller bearings which are very vigorously hardened indicate by their behavior upon etching in the proper manner that a similar condition obtains there. Fig. 2 shows several hardened steel balls which split when they were etched with hot concentrated acid; cold-rolled steel shafting will sometimes behave similarly when deeply etched in the same manner.

The cracking of the metals illustrated above when subjected to the proper etching reagents and the similar deterioration "season cracking," which may occur spontaneously in service, are not to be regarded simply as a result of structural variations. However, the distortion of the structure in the cold-worked metals in which such conditions occur is very pronounced and undoubtedly is contributory in a very large degree to the unusual behavior of the metal.

[3] H. S. Rawdon and S. Epstein, Bureau of Standards Tech. Paper 156, "Metallographic Features Revealed by the Deep Etching of Iron and Steel"; CHEM. & MET., vol. 22, p. 505, March 17, 1920.

[4] H. S. Rawdon, "The Use of Mercury Solutions for Predicting the Season Cracking of Brass," A.S.T.M. *Proceedings*, vol. 17, pt. 2, p. 189, 1917.

[5] P. D. Merica and R. W. Woodward, Bureau of Standards Tech. Paper 82, "Failure of Brass; 1.—Microstructure and Initial Stresses in Wrought Brasses of the Type 60 Per Cent Copper and 40 Per Cent Zinc."

Present Status of the Belgian Iron and Steel Industry

In spite of the active reconstruction work which has been carried on in Belgian metallurgical centers since the armistice, this industry is still far from obtaining its pre-war position, reports Trade Commissioner Cross, of Brussels. Particularly in the large plants centering about Liége, regardless of relative success in recruiting skilled labor and in recovering confiscated machinery, it has not been possible during the two years which have elapsed since the armistice to efface the damage done by the invading forces, since the resumption of production has been complicated by the necessity of diverting to repair work a relatively large proportion of the available help.

In the Province of Liége, out of 240 metallurgical plants of all sorts, ten are completely shut down, fourteen are producing less than 25 per cent of their 1913 quota, sixty-two are producing between 25 and 50 per cent, sixty-five between 50 and 75 per cent, and sixty-three are producing between 75 and 100 per cent. Only sixteen are giving over 100 per cent of the pre-war production.

The necessary capital for restoration and increased running expenses has been obtained to some extent through indemnities paid by the Belgian Government and largely by issues of new capital and debentures.

Out of fifty-one blast furnaces now existing in Belgium, twenty-one are in operation and seven others are substantially ready for firing. There were but twelve blast furnaces in operation on Jan. 1, 1920. Those at present restored have a capacity of 65 per cent of the 1913 production. Though there appears to be enough coke for all immediate needs, there is an appreciable shortage of enough coal of high volatile content for gas generators and Martin converters, and the plants which do not exploit their own coal mines are not able to accumulate large stocks.

Owing to the general destruction of rolling mills and the difficulty of renewing stocks of rolls, Belgian market offerings present a somewhat limited scope, but with the further progress of restoration a wider variety of products may be looked for.

Until the spring of 1920 the production of Belgian metallurgical plants was entirely engaged by the needs of domestic construction and by exports to northern France, and the competition for their products resulted in a considerable rise in prices, which reached its peak about the middle of May, 1920. From this date forward a slow and steady downward movement began. German competition is already making itself felt in finished steel products, such as bars, beams and rails.

The autumn of 1920 found the Belgian iron and steel industry producing 51 per cent of its pre-war production of pig iron, 69 per cent of finished iron, 54 per cent of steel ingots and 62 per cent of finished steel, thus indicating notable progress since the beginning of the year. The situation in fuel and raw materials has improved, especially on account of regular supplies of German coking coal and the operations of restored coke ovens.

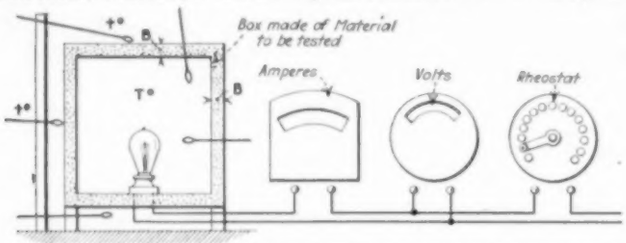
Many plants aside from reconstruction work have modernized and extended their installations. The high prices, which rendered production extremely profitable, since the armistice have since May, 1920, given way before a slackening of demand. Furthermore, the problem of readjusting labor costs to falling prices creates an element of uncertainty in the present situation.

Relative Heat Conductivities of Some Insulating and Building Materials

By James J. Lichtin

THE object of this investigation has been to determine by the so-called air box method the relative heat conductivities of materials used for insulation of apparatus, vessels, tanks, etc., used in the chemical industries or as building materials. Further, the aim has been to compare these conductivity values with the conductivity of a new porous insulating and building material "Porete," made of cement and sand, data of which have not been published before.

It was therefore necessary to conduct the tests of the different materials under equal conditions as nearly as



SCHEMATIC ARRANGEMENT FOR HEAT-CONDUCTIVITY TESTING

possible. A number of cube-shaped boxes were constructed of the different materials of practically the same dimensions, which were approximately 8 x 8 x 8 in. inside. The thickness of the walls was about 1 in. An electric lamp was used as a heating element inside these boxes. The electric current was regulated by a rheostat and measured by accurate voltmeter and ammeter.

The temperature inside was measured by two thermometers and outside by three thermometers, all located as shown in the accompanying drawing, and these thermometers were placed in the same relative position on each testing box.

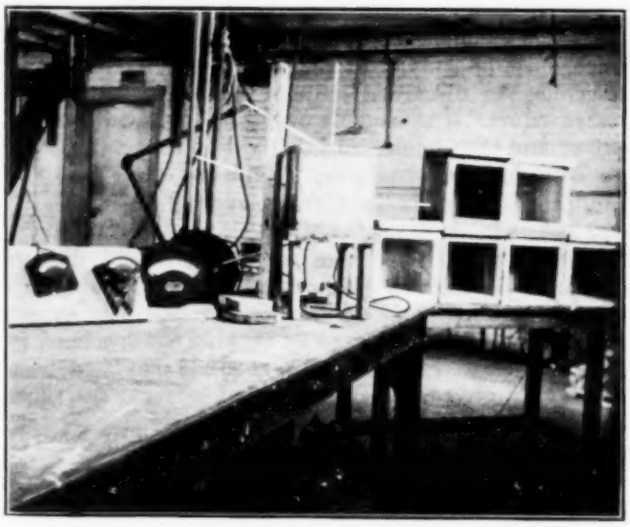
The testing apparatus was set up in the basement of the laboratory, where the room temperature was fairly constant. No readings were taken during the first twenty-four hours in order to allow time for all conditions to reach an equilibrium. After this readings were taken about every two hours.

The conductivities K as shown in the accompanying tables in B.t.u. were calculated from the formula

$$K = \frac{3.415 \times B \times W}{12 \times A \times (T - t)}$$

where B is the thickness of the walls in inches, A the area in sq.ft., W the watts from the voltmeter and ammeter readings and $T - t$ the difference between the inside and outside temperatures as indicated by the thermometers. Area A was considered to be the mean between the inside area and the outside area of the box.

The thermal conductivity so measured is the quantity of heat in B.t.u. that flows through 1 sq.ft. unit area



HEAT-CONDUCTIVITY TESTING APPARATUS

of plates, through a unit thickness of 1 ft. having a unit difference of 1 deg. F. between its faces.

It is clearly seen from the table that the conductivity of Porete stands midway between that of gypsum and yellow pine. Comparing our conductivity values with those obtained at the U. S. Bureau of Standards,[1] where the plate method has been used in testing approximately the same materials, we note how nearly our figures agree with theirs, thus:

	Our Conductivity Values in B.t.u.	Density, Lb./Cu.Ft.	Conductivity in B.t.u. Equiv., U. S. Bu. of Stand.	Density, Lb./Cu.Ft.
Yellow pine	0.0719	40	0.0799	34
Air cell	0.0335	13	0.0399	8.8
Cork board	0.0277	11.7	0.0256	11

We are aware that the results thus obtained cannot be accurately compared with results of similar tests made under different conditions, because the conductivity K found in this way is not the heat transmitted only through the tested material of the thickness B, but it is the heat which passes through the layer of air from the inside thermometer bulb to the wall, hence through the wall, and thence from the outside of the wall to the outside thermometer bulb.

The results will be different from the results of tests where air contact has been excluded, and they will also be different from results of tests where fans or other devices have been used to keep the air in motion, thereby diminishing the resistance to the air entering into the wall of the material to be tested. However, as the figures arrived at are those under which the materials are used ordinarily as insulators or in building construction, they will give a good idea of the relative values of heat conductivity of the materials tested.

Laboratory of the Verona Chemical Co.,
Newark, N. J.

[1] "The testing of Thermal Insulators," by H. C. Dickinson and M. S. Van Dusen, *Journal*, American Society of Refrigerating Engineers, September, 1916.

Material	Box, Inside Dimension, In.	Walls, Mean Thickness B, In.	Mean Area, A, Sq.Ft.	Vol. Box, Cu.In.	Weight Box, Lb.	Sp.Gr.	Wt. per Cu.Ft. Lb.	Elec. Current Consumed, W Watts	Mean Inside Temp., T Deg. F.	Mean Outside Temp., t Deg. F.	Temp. Difference $T - t$ Deg. F.	Heat Conductivity K
Concrete, 1 cement : 2 sand	8⅛ x 8 1/16 x 8 1/16	1 1/16	3.612	618	45.63	2.01	128	49.0	107.2	81.2	26.0	0.1760
Gypsum board	8⅛ x 8⅛ x 8⅛	1⅛	3.619	588	21.25	1.00	62.5	31.6	115.7	82.7	33.0	0.0846
Porete, reinforced with exp. metal	8⅛ x 8⅛ x 8 1/16	1 1/16	3.565	546	19.40	0.98	61	44.5	131.5	88.1	43.4	0.0786
Yellow pine, North Carolina	8 1/16 x 8 1/16 x 8⅛	1 1/16	3.541	558	12.88	0.64	40	50.5	145.5	83.7	61.8	0.0719
Air cell, asbestos board	8 x 8 x 8½	1½	3.530	572	4.40	0.21	13	29.7	156.0	78.0	78.0	0.0335
Cork board	8 x 8 x 8	1½	3.470	566	3.83	0.187	11.7	6.82	94.9	72.9	22.7	0.0277

Possible Uses for the Spent Shale From Oil Shale Operations

By Kirby Thomas
Consulting Engineer

ONE of the obvious problems in connection with the plans for the treatment of oil shales to recover oil and byproducts is the handling and disposal of the waste material. This waste amounts to from 60 to 80 per cent by weight of the material treated, depending on the amount of volatile hydrocarbons in the shale and on the amount of water, combined and uncombined. The bulk percentage is somewhat more than the weight percentage because of the expansion of the shale pieces and particles under the treatment process and because of the greater space necessarily occupied by broken or ground material of the physical character of shale.

Disposal of Spent Shale

In an operation having a throughput of a thousand tons daily the mere handling of the spent shale and its removal to a waste dump is a large mechanical problem. The cost of this feature of the operation must be a proportionately considerable item in the production costs. There exists also the necessity of providing suitable and adequate dumping sites. The factor of the cost of mining and breaking at the plant of this large percentage of waste material must be considered also, for the oil shale operations at best are in the class of the low-grade metal mines as to the relation of cost of operation and value of the product. In respect to the waste, the problem is somewhat similar to that with which the asbestos miners are confronted, only the value of the product is much greater in the case of the asbestos operations.

Fortunately the extensive oil shale deposits in Colorado and Utah, by reason of the usual cliff-like character of the shale beds which are likely to receive attention at the start and for a very long time, present very favorable conditions for the disposal of the waste, for gravity mill and waste dump sites generally can be selected and there is always plenty of outdoors for the unlimited extension of the dumps. In one instance it was proposed to place a treatment plant on a level site near the Grand River and it was planned to dispose of the waste by dumping it into the river. It was found that Uncle Sam and the state were likely to have something to say about such a procedure in the interests of control of flood waters for irrigation purposes and to protect the fish in the river. In the Eastern states the conditions as to waste disposal sites are not so favorable either from topographic considerations or from the standpoint of available dump area.

Value of Spent Shale

Very little attention has been given to the waste disposal phase of the oil shale operations or to the investigation of possible uses for the waste material which would give it some value and aid in its handling and perhaps also contribute an important item to the aggregate of the products recovered from the shale by the processes proposed.

The waste shale is nothing more nor less than clay. Of course the different shale deposits vary somewhat in the general character of the mineral or inorganic material of which they are composed due to conditions affecting their origin especially as related to the character of the land surfaces from which in all cases the material must have been derived in the first instance. The Colorado-Utah deposits have undergone no change through geological agencies such as result in the metamorphism and general rearrangement of the crystalline and molecular status of the original rock. In only a few localities have these beds been folded or even tilted since deposition. Such a condition does not prevail in some of the other shale deposits of the Western area. The Nevada deposits at Elko and the California deposits near Santa Barbara are steeply inclined and in some cases folded. Generally in these Western deposits there have been no changes or alteration through the heat agencies of volcanic intrusions or lava flows. Such conditions and relations prevail in a few Western localities, but these are not likely to be considered for the basis of operations now or for a long time to come.

It is to be noted that the recent flow of basaltic lava which covers some of the edges of the Green River shale beds of Colorado and which was once probably much more extensive has hardly changed the topmost layers lying in direct contact with the lava beds. The Eastern shale deposits are older than those of the West, being, in the Central states, mostly Devonian or belonging to the Mississippian member of the Lower Carboniferous. These are relatively undisturbed over large areas in Ohio, Indiana, Kentucky, Tennessee and Illinois and are free from the influence of all plutonic agencies. They have been somewhat tilted in some localities and in some cases there has been limited folding of such a character that it has changed the hydrocarbon elements of the shale into graphite. It is probable that some of the folding and orogenic movement has also resulted in the removal of the hydrocarbon material from the shale by influences of heat and pressure, or heat with pressure, and its transformation into the crude petroleum which is now being recovered by means of drilled wells tapping the natural catchment reservoirs in the overlying or perhaps also underlying strata. These Eastern shales are generally more indurated by reason of their greater age and perhaps the greater and longer pressure to which they have been subjected.

Chemical Composition of Oil Shales

The shales everywhere vary slightly in their content of what may be called extraneous minerals. There is found a variation in the free silica and also in the silica which has come in by solution and percolation. There are small variations in the iron content and some also in the lime proportions. Sometimes other minerals, including the ores of the precious and common metals, are to be found in small amounts in the shale in irregular and limited localizations.

ANALYSIS OF A SAMPLE OF A KENTUCKY SHALE DEPOSIT

Analysis of Shale

	Per Cent
Silica	36.32
Alumina	11.60
Iron oxide	2.00
Titanium oxide	.40
Calcium oxide	5.72
Magnesium oxide	3.82
Sulphur	2.01
Potash	2.91
Soda	1.30
Total nitrogen expressed as ammonia	1.21
Loss of ignition (organic matter, etc.)	34.04

Distillation Test

Maximum temperature of distillation, deg. F.	1,560
Oil recovered per ton of shale, calculated from small-scale distillation test, 160 lb. or gal.	20.1
Gas produced per ton of shale, calculated from small-scale distillation test at 30 in. mercury pressure and 60 deg. F., cu.ft.	3,600
Yield of ammonium sulphate per ton of shale, calculated from small-scale distillation test, lb.	4.32
Carbon in residue, per cent	13.02

A complete analysis of a sample of a Kentucky shale deposit in Powell County made by the Detroit Testing Laboratory is available. The analysis is given in the accompanying table.

This analysis is probably fairly typical of most of the Eastern shale deposits now under consideration. In the Western shale generally the percentage of the volatile matter is greater, but the ratio of the other elements in the residue is about the same judging from the small amount of precise chemical data at hand.

Spent Shale as Fuel

After treatment the spent shale generally contains a considerable percentage of fixed carbon. This is called "coke" and it has a heat value which it is proposed to use as fuel in some of the process plans to supplement the non-condensible gas which is an unavoidable product of all of the retort operations. As this gas and the fixed carbon result from the imperfections of the applications of the method, they are a measure of the inefficiency of the process and it is small satisfaction to be able to convert them to some use of less value than would be the case if they had been recovered in the operation as valuable oil.

Spent Shale as a Non-Conductor Material for Electrical Applications

The spent shale with the fixed carbon—from 7 per cent up—has special qualities for use as a cheap material for a non-conductor for electrical applications. Experiments have been made in this use with reported good results. The material is molded wet and baked, or pressed into suitable shapes and forms. Similar experiments have been made with the untreated shale, and in consideration of the relatively larger carbon content, though not as fixed carbon, the results may be expected to be better than with the spent shale. This fact and the great abundance of the original shale make the effort in this line to find an outlet for the spent shale defeat itself.

Spent Shale as a Material for Making Brick

Practical tests of the availability of the spent shale for making brick for constructional purposes have been made with the material from the Colorado deposits. The results are very satisfactory, as might be expected. The brick have a greater strength for their size and weight than the brick from ordinary clay or slate. This point will give the shale brick a clear preference in an even competition aside from the probable lesser cost of the material for making brick, if the already mined and crushed waste shale is used. It is possible, too, that the physical condition of the clay from the spent shale and the effects of the preliminary heat-treatment may be beneficial and of advantage in its use for brick-making. This possible use for the waste will have a limited importance with the Western shale deposits mostly because of their remoteness from the best market for the brick. Of course tile and other similar products can be made from shale clay also, and these may furnish local needs in the West and have a better market as far as the Western operations are concerned.

In the East, where the shale deposits are situated in thickly settled regions, the making of brick affords an important and practical outlet for large quantities of the spent shale. In fact it is conceivable that some of the operations in Ohio and Indiana, as proposed, may find a profitable demand for their whole spent product for making brick and tile and such products, which are used in great and increasing quantities at the present time.

Use of Spent Shale in the Cement Industry

A use which has the possibility of taking care of a very large amount of the spent shale is connected with the plan to co-ordinate the shale operations with the cement industry. The waste heat from the cement kilns can be used to "boost" the heat for the oil shale retorts, and conversely the waste heat for the shale operation can be turned back to the cement kilns.

This idea has been embodied in patent 1,323,294, Dec. 2, 1919, taken out by Robert W. Lesley of Philadelphia. Mr. Lesley is a cement engineer of note and is largely interested in the cement companies of the East. The possibility of the making available of an essential ingredient of so low priced a product as cement at a lesser cost is conversely of more significance to the vast established cement industry than it is incidentally to the newer oil shale business.

It is probable that this relation is fully appreciated by the cement interests, which are now apparently quite well balanced in their competitive status. Generally it will be practicable to assemble the other materials for cement-making at the localities where the Eastern shale operations are proposed. These localities are chiefly in convenient positions to be correlated thus with the cement operations both as to assembling the raw materials and the distribution of the finished product. The projected shale operations in Kentucky are in the centrally located Powell County. The Indiana deposits of shale are in Floyd, Jefferson, Clark, Jennings, Scott and Jackson Counties. Other shale deposits are found in southern Ohio and eastern Tennessee, and in central Illinois. It is likely that they will be found in Pennsylvania and in western New York. This distribution is suggestive of a possible close interrelation between the shale industry and the cement industry if the mutual advantage as above discussed is proved by actual test on a large scale.

Other Possible Uses for Spent Shale

A plan to mold the waste shale for railroad ties has been experimented with. It is claimed that a tie so made is strong and of course it is lasting. The claim is also made that a shale tie has a certain amount of elasticity which is lacking in a cement tie or in the sometimes used steel ties. The spent shale probably will soon make soil suitable for tilling, differing in this respect from most of the waste material from quarries and mines.

Economic Advantages Resulting From the Use of Spent Shale

Taken in connection with the expectation that the shale will yield ammonia, and in some cases potash, in addition to the oil, the possibilities for useful applications for the waste are of great importance to the successful establishment of this new and needed industry in this country.

The determination of the practicability of these supplemental products from the oil shale will have the greater benefit to the Eastern shale deposits clearly and will go a long way, taken in connection with the collateral advantage in marketing the oil and other distillation products, in offsetting the lower oil yield of the Eastern shale—about one-half that of those of Colorado and Utah.

Manufacture of Synthetic Ammonia at Oppau, Germany*—III

Manufacture of Ammonium Sulphate, Ammonium Chloride and Ammonium Nitrate — Coke Plant, Power Stations and Other Supplementary Plants Required to Make the Oppau Works a Complete Entity—General Organization—Conclusion†

THE process employed at the Oppau works for the manufacture of ammonium sulphate with gypsum is based on the difference of solubility in water of calcium sulphate and calcium carbonate and is analogous to the Solvay process for the manufacture of soda. The process is protected by a French patent of the French Société Industrielle de Produits Chimiques.

The gypsum used is brought to the plant from the Neckarzümmer quarries by 108 special cars of thirty-four tons capacity.

The gypsum is first crushed to about fist size and charged into storage bins, whence it is carried by a bucket elevator to a belt conveyor leading to the hoppers of pulverizers. The pulverized gypsum is conveyed by an endless screw to a bucket elevator, which feeds the hopper of a recording automatic weighing machine. From this weighing machine the gypsum is carried into a hermetically closed reservoir provided with an agitator and into which is added water sufficient to prepare the required gypsum paste. The plant has three reservoirs of 3-m. diameter and 3 m. high. This paste can be stored in two reservoirs 5 m. in diameter and 5 m. high provided with agitators. The dust above the hoppers is collected by a ventilator and carried to a dust collector.

The paste is then brought into thirteen cylindro-conical reaction vats 3 m. in diameter and 1.5 m. high at the cylindrical part, and 1 m. high at the conical part. These vats are provided with belt-driven helicoidal agitators which are maintained at 45 deg.

The paste is fed through one pipe, the carbon dioxide through eleven pipes located around the cylinder and the ammonia through one pipe. The gases, after reacting, are brought by a pipe to a separator located above the cover. The separators are connected by a double piping, of which one is endless, the other leading to washing towers for the recovery of the ammonia. There are four such towers 12 m. high and filled with Raschig rings.

The circulation of the carbon dioxide is insured by a double compressor driven by a steam engine and by three ventilators driven by 150-kw. motors.

The contents of the reacting vats are led to two reservoirs 4 m. in diameter and 5 m. high provided with agitators and thence to three similar reservoirs in which the reaction is completed. The duration of the reaction is from nine to ten hours.

The mass is then sent to filtering vats. There are ten such vats 4 x 2 x 1.5 m., each vat containing twenty-eight 5-cm. thick plates, closed by filtering fabrics supported by sheet-iron plates provided with 5-mm. holes. Pipes from the bottom corner of the plates lead to a manifold which ends in three branches, each branch connected to a separator. The corners of the plates diagonally opposite to the lower outlets are connected to a manifold vacuum duct. From the separators the filtrate is siphoned into reservoirs.

The calcium carbonate adhering to the plates is separated by the injection of compressed air and led into two separators 2.5 m. high and 1 m. in diameter, whence it is transported by an endless screw into two tanks 3 m. in diameter and 3 m. high. These tanks are emptied by a circulating jet of water from a centrifugal pump.

The ammonium sulphate solution is taken from the reservoirs, filtered and stored in reservoirs of 4-m. diameter and 5 m. high. The concentration of the solution is about 25 per cent. From these reservoirs the solution is brought into the concentration building, containing six double-effect evaporators of 2.5-m. diameter and 6 to 7 m. high, into which steam arrives at the middle part. The crystals formed are separated from mother-liquor in horizontal centrifugal dewaterers. The drained crystals are transported by belt conveyors to two coal-fired rotating drying furnaces. The dried crystals are then stored in storage bins 100 m. long, 50 m. high and 30 m. wide. Additional ammonium sulphate crystals are obtained by cooling the mother-liquors. These crystals are separated by filter presses or by draining, dried and stored in the above storage bins.

The Oppau works has a capacity for treating 1,000 tons of gypsum per day.

Manufacture of Ammonium Chloride and Solvay Soda

The preparation of ammonium chloride and sodium carbonate by the Solvay process (action of ammonia and carbon dioxide on salt) takes place in vats *A* (Fig. 15).

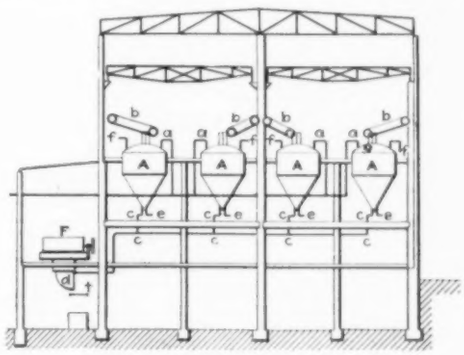


FIG. 15. SCHEMATIC ARRANGEMENT FOR THE MANUFACTURE OF AMMONIUM CHLORIDE

There are thirty-six brick-lined vats 3.5 m. in diameter, 1.5 m. high for the cylindrical part and 3 m. high for the conical part, and provided with helicoidal agitators driven by belts *b* and with cooling coils. The gases, ammonia and carbon dioxide arrive at the bottom of the vats through six pipes.

*From *La Technique Moderne*, November, 1920, pp. 449-460.

†For Parts I and II see CHEMICAL & METALLURGICAL ENGINEERING, vol. 24, Nos. 7 and 8, pp. 305 and 347, Feb. 16 and 23, 1921.

The brine is prepared in a semi-cylindrical trough, decanted and stored in reservoirs 4 m. in diameter and 4 m. high, provided with agitators and with water and steam inlets. This brine is led to the reaction vats through *e* at the bottom of the vats.

The gases escaping at *f* are sent to two ammonia recovery columns. The paste leaves at the lower part of the vats at *c* and enters four tanks with filtering bottoms. Some of the crystals remain on the filter and are drained, the others are separated in rotary filters *F*.

The sodium bicarbonate crystals collected from the drainer and filter are conveyed to storage by a belt conveyor *t*.

The filtered solution is pumped into three 60-cu.m. reservoirs and thence into twelve double-effect concentrators. The concentrated product is sent into draining tanks. The drained crystals of ammonium chloride are conveyed to the storage and the solution is pumped into four reservoirs of 2 m. diameter and 6 m. high, where an additional concentration takes place with the separation by draining of another part of crystals, which are conveyed to the storage. The final solution is pumped into reservoirs 4 m. in diameter and 5 m. high.

The crystals of ammonium chloride from the storage are conveyed by belt conveyors and bucket elevators to rotary driers which are similar to those used for the drying of the ammonium sulphate crystals. The dried ammonium chloride is stored in storage bins.

The proportions of the reacting products are 78 ammonia for 269 salt. The action of the ammonia lasts from one and one-half to two hours and that of the carbon dioxide eighteen hours. The production capacity is 160 tons of ammonium chloride per twenty-four hours.

Manufacture of Ammonium Nitrate

Ammonium nitrate is manufactured by the direct action of nitric acid on ammonia. The reaction takes place in eight vats similar to those used for the manufacture of ammonium sulphate or ammonium chloride. The ammonia enters at the bottom through six pipes; nitric acid, from brick reservoirs, tarred inside, 4 m. in diameter and 3 m. high, is pumped into three stoneware cylinders 1.5 m. in diameter and 2 m. high, whence it flows into the reaction vats.

The nitrate solution is collected in reservoirs 3 m. in diameter and 3 m. high, whence it is sent to evaporators.

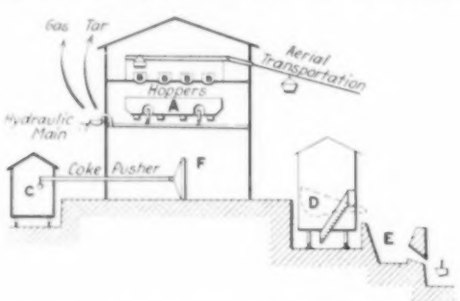


FIG. 16. SCHEMATIC ARRANGEMENT OF COKE PLANT

These evaporators are tubular boilers, eight in number, of 2-m. diameter and 3 m. long. Steam at 12 kg. pressure circulates in the tubes and the boiler is under a vacuum of 60 to 70 cm. of mercury. The steam formed is received into a tubular condenser. The concentrated solution is received in reservoirs, whence it is taken to be treated for the production of nitrate in a manner analogous to that for the production of ammonium chloride or ammonium sulphate, or mixed with a powdered salt, particularly potassium chloride, for the production of special fertilizers. This mixing takes place in flat vats provided with agitators. The paste formed is emptied by an endless screw and will be (the installation is not yet completed) conveyed by belt conveyors and bucket elevators to rotary driers and the dried product stored in two 100-m. long storage bins now under construction.

There is also an ammonium nitrate solution concentration plant consisting of two open vats heated by steam coils.

Supplementary Plants at the Oppau Works

The Oppau works has been erected with the idea of being a complete entity and thus, besides the different departments described above, it also has all the needed supplementary departments such as manufacture of catalysts, coke ovens, motive power, coal-handling, water supply and laboratories.

Manufacture of Catalysts

The catalytic masses are manufactured in a separate building which contains crushers, mixers, pugmills and furnaces. The conveying is done by belt conveyors and bucket elevators.

Coke Plant

The coke plant consists of two batteries of sixty-five ovens of the Collins system. Size of ovens, 8 m. long, 2.5 m. high, 0.40 m. wide (Fig. 16).

The coal is brought in by aërial transportation, discharged into hoppers *B* and bins *A*, whence it is charged into the furnaces *F*. The coke pusher *C* sends the coke to the quenching chamber *D* and hopper *E*, whence it is conveyed by aërial transportation to wherever needed.

The ovens of each battery have a common hydraulic main. The gas is treated for the separation of light oils. This takes place in two groups working in parallel, each group consisting of six towers 12 m. high, 3 m. diameter, which work in series. The gas then passes a rotary meter and is stored in a 10,000-cu.m. gas holder.

About 850 tons of coal are coked per twenty-four hours, giving about 650 tons of coke.

Motive Power

There are two electric power stations, one using producer gas, the other equipped with turbo-alternators. Both stations produce three-phase, 50-cycle, 3,000-volt current.

The lean gas power station comprises two Siemens-Schuckert 1,875-kw. alternators direct-connected to two 2-cylinder tandem Nuremberg gas engines and two 3,380-kw. Siemens alternators direct-connected to Thyssen gas engines. The exhaust gases from the Nuremberg gas engine enter tubular boilers generating steam at 4-kg. pressure, and the exhaust gases from the Thyssen engines enter tubular boilers generating steam at 12-kg. pressure and superheated to 270 deg. C. About 13 per cent of the lost heat is thus recovered, giving about 0.36 kg. of steam per kw.-hr.

The turbo-alternators power station comprises one Curtiss 6,250-kw. turbine with an A. E. G. (Allgemeine Elektricitäts Gesellschaft) alternator, two Quelly turbines with Siemens-Schuckert 4,000-kw. alternators and one Brown-Boveri turbine with a 4,000-kw. Brown-Boveri alternator.

The boilers (Fig. 17) are formed of four horizontal parallel cylinders *A*, *B*, *C*, *D*. The cylinders *A* and *C* are connected by ten vertical tubes *F* and the cylinders *B* and *D* are connected by ten tubes *E*, which form a 60-deg. angle with the horizontal. Cylinders *A* and *B*, *C* and *D* are also connected respectively by two 25-cm. tubes *G* and four 36-cm. tubes *H*. Cylinders *C* and *D* are besides connected by three vertical tubes with drums *I*. The steam is superheated in a superheater consisting of coils. Lignite briquets are used as fuel and are fed by mechanical stokers *K*. Four groups of boilers are also arranged for firing with gas. The total heating surface is 17,785 sq.m. and the grate surface 355.7 sq.m. The production of steam is about one ton per hour per sq.m. of grate. The consumption of fuel is 2,400 tons lignite briquets per day, which is equivalent to 1,300 tons of coal.

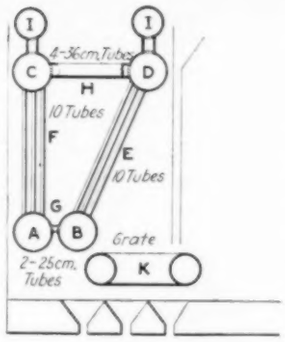


FIG. 17. ARRANGEMENT OF BOILERS, TURBO-ALTERNATORS CENTRAL STATION

Besides these two central power stations there are a number of steam engines and steam turbines installed separately in different buildings and connected to different machinery such as pumps, compressors and ventilators. These steam engines and turbines receive the steam from the central boiler room or from individual boiler rooms, using the hot gases from the different reactions in the respective buildings.

Coal Handling

On the average the plant uses over 2,000 tons of fuel per day, practically all of which is handled mechanically (only 5 per cent of the total power required is furnished by manual labor). The fuel arrives by barges on the Rhine River, and is unloaded by hoists running on overhead rails located parallel to the river. These rails *A* form a U with the two branches of unequal length. The short branch (450 m.) runs along the Rhine, the long branch (700 m.) runs along the fuel storage yard. The cars are hauled by a continuous cable manipulated from the cabin *B* (Fig. 18).

The unloading is done by three hoists *C*. Each hoist consists essentially of a beam *D* (Fig. 19) inclined at 46 deg., the lower part of which is jointed and kept in the dotted position when not working. A bucket *e* runs along the beam. The coal taken from the barge is emptied into hopper *F* after it has been weighed by an automatic weighing machine. From the hopper the fuel may be loaded into cars *W* running on rails to the desired place, or into buckets running on aërial transportation *G* which is provided with a series of switches (Figs. 20 and 21) for directing the disposal of the fuel in the buckets. The switching is done as follows: The aërial rails have side tracks, H_1 and H_2 connected to the main track by inclines, K_1 and K_2, and a series of pulleys L_1, L_2, L_3, for the driving cable. The pulleys are so arranged that under normal conditions the buckets when approaching the side tracks H_1, H_2 are detached from the main driving cable and by their own momentum run over the sidetrack and incline back to the main track, where they are again caught by the driving cable.

If switching is needed the bucket, instead of running back to the main track, is directed to the desired track branch and is pushed along this branch by manual labor until it is attached to the respective driving cable. *M* and *N* are transmission stations.

Along the other branch of the U there are five cranes *Q* and hoists *P* for loading the coal from the storage yard into bins running along the aërial transportation lines to wherever needed. By convenient switches the fuel can be directed to fuel storage bins located in different parts of the plant. Special switchings connect the main aërial transportation lines to the coke plant and gas producer buildings.

Water Supply

The plant consumes on the average 7,000 liters of water per second. This water is supplied from the River Rhine by seven centrifugal pumps driven by electric or gas motors. There are two water reservoirs connected to the river by two conduits respectively 1.70 m. and 1.10 m. in diameter. The water before being used is filtered through a 50-cm. sand layer in eighty sheet-iron vats of 15 x 3 x 1-m. dimensions. This filtering implies a loss of 2-m. pumping head, which is to be added to the 6-m. head required for supplying the plant. The size of the discharge pipes of the centrifugal pumps varies from 60 to 100 cm. according to the type of the pump. There are nine pumps, of which six are gas-motor-driven and three electric-motor-driven. All the water is first sent into a 1.3-m. diameter reservoir, whence it is distributed by three main branches to wherever needed.

Laboratories

Each department has its own laboratory where all the routine work analyses are made and in which there is besides a special personnel of chemists doing research work.

There is also a main laboratory directed by Dr. Mittach, where fifteen to twenty chemists and fifty to sixty subordinates are employed for research work affecting the efficient operation and improvements of the general process.

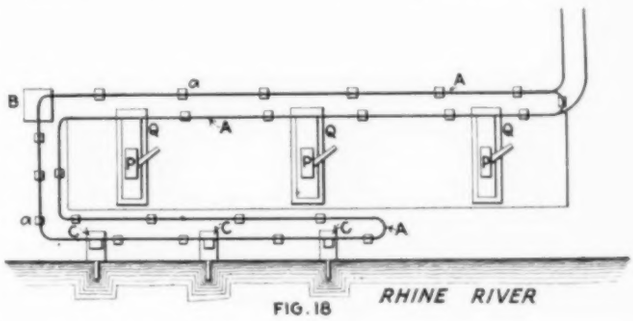


FIG. 18

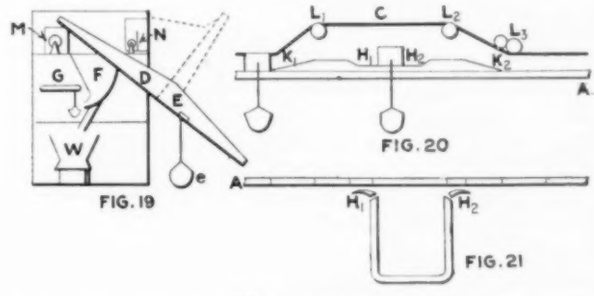


FIG. 19

FIG. 20

FIG. 21

FIGS. 18 TO 21

Fig. 18. Schematic arrangement of the coal unloading installation.
Fig. 19. Unloader.
Figs. 20 and 21. Switching arrangement.

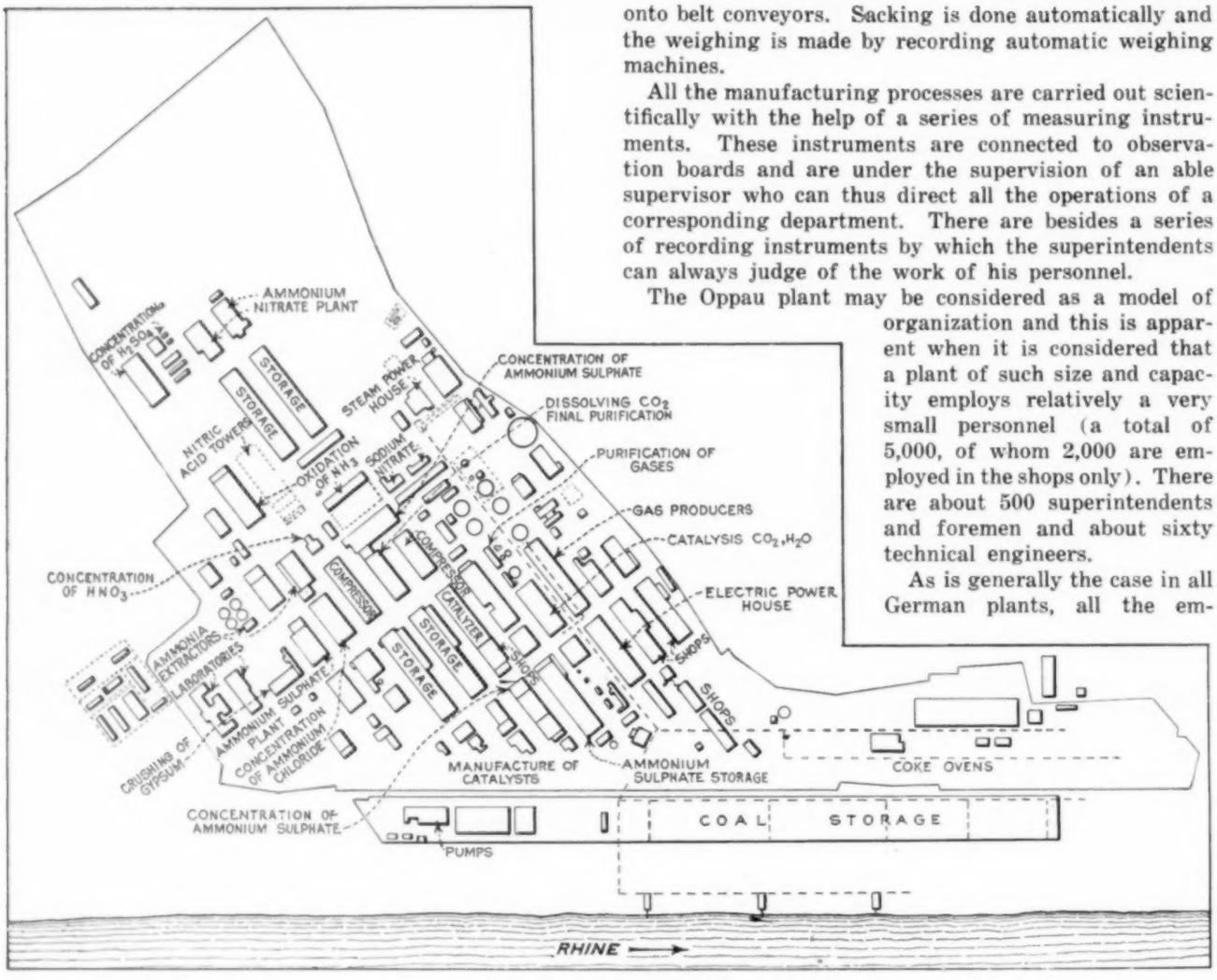


FIG. 22. PLAN OF THE WORKS

The Oppau plant has a number of special shops for forging, turning, mounting, carpentry, building, etc., in which practically all the requirements of the plant can be taken care of. Only the heavy forgings and foundry pieces, electric motors, steam engines and gas motors are of outside make.

The entire works at Oppau employs about 5,000 men, of whom about 2,000 are employed in the shops.

General Organization

The plant as shown in Fig. 22 occupies an area of about 800 hectares. Its construction was begun in 1912 and offered some difficulties owing especially to the small resistance of the soil. It was necessary to go to a depth of 17 m. to find a solid base for the foundations.

All the buildings are spacious, well lighted and ventilated. Pipe lines for gas, steam and solutions are laid all over the plant, some overhead and some underground. When the pipes are laid underground they are inclosed is easily accessible conduits.

The greatest care has been exercised to reduce the manual labor in all the plant to a minimum. All the shops are provided with cranes, electrically-driven hoists of appropriate power and strength. The transportation of the solid materials is made in special cars with automatic discharge or by belt conveyors, endless screws or bucket elevators. The fertilizer storage bins are provided with hoists on cranes which charge the material onto belt conveyors. Sacking is done automatically and the weighing is made by recording automatic weighing machines.

All the manufacturing processes are carried out scientifically with the help of a series of measuring instruments. These instruments are connected to observation boards and are under the supervision of an able supervisor who can thus direct all the operations of a corresponding department. There are besides a series of recording instruments by which the superintendents can always judge of the work of his personnel.

The Oppau plant may be considered as a model of organization and this is apparent when it is considered that a plant of such size and capacity employs relatively a very small personnel (a total of 5,000, of whom 2,000 are employed in the shops only). There are about 500 superintendents and foremen and about sixty technical engineers.

As is generally the case in all German plants, all the employees, engineers and laborers alike, are given well-determined tasks and do not have access to other departments than their own unless they have special permit.

Conclusion

The cost of the Oppau plant was 300,000,000 marks ($75,000,000 at pre-war exchange rates). It has a capacity of 300 tons of ammonia. (It is said that the Merseburg plant has a capacity of 900 tons of ammonia.) It is estimated that at pre-war prices the cost per kg. of combined ammonia was 0.70 mark, and it is not surprising that with such production costs it was very easy to compete with the Chilean and Peruvian nitrates and to make Germany independent of these natural supplies. It is to be taken into consideration that this low cost was made possible by the abundance of fuel and river transportation facilities.

The French are now working in quite a different direction from that of the Germans for the manufacture of synthetic ammonia for fertilizer purposes. Georges Claude is doing excellent work on dispensing with the use of the costly sulphuric acid for making ammonium sulphate fertilizer and instead he will use the now wasted byproduct of the Solvay process and produce an ammonium chloride fertilizer.[1]

[1]The characteristic distinctions between the Haber and the Claude processes for the production of synthetic ammonia were summarized in CHEM. & MET. ENG., vol. 23, p. 395, Sept. 1, 1920.

Molybdenum Steels*

Development of Molybdenum Steel in America—Early Experiments with This Element in Complex Alloys for Tools—Recent Successful Utilization in Mechanical and Structural Steels of High Strength and Great Adaptability

By John A. Matthews†

IT IS twenty years since the writer made his first molybdenum steels and others were making them commercially five years earlier, but the prevailing opinion seems to be that molybdenum steels are new; from time to time the daily press speaks of important discoveries in Europe and intimates that American steel makers have much to learn in regard to alloy steels. The arlier experiments were largely confined to the use of relatively high percentages of molybdenum in tool steels and permanent magnet steels. Recent developments deal with the types of alloy structural steels used for airplane, automobile and other engineering requirements; in these, the molybdenum content is usually less than 1 per cent. The earlier types generally have been unsuccessful commercially, but the newer types of steels are becoming of increasing importance.

The war showed our dependence on foreign sources for alloying metals; molybdenum alone is widely distributed in the United States and seemingly abundant. Many deposits are now of commercial interest, owing to location and relatively small amount of ore available, but other deposits are being developed and a stable source of supply seems well assured.

In tool and magnet steels, it was early found that 1 part of molybdenum was equivalent to from 2 to 2.5 parts of tungsten. The permanent magnet steels investigated by Mme. Curie, [1] in 1898, contained from 3.36 to 4.05 per cent molybdenum; in 1902, Dr. E. L. French and the writer thoroughly tested steels containing from 2.0 to 4.0 per cent. These steels gave satisfactory tests for permanence, but were low in residual density and much more sensitive to hardening than the corresponding tungsten products. We discontinued work with them theerfore, and have no advice that such steels have been used commercially here or abroad.

Prior to the development of the Taylor-White process and the modern high-speed steels, air-hardening steels were in general use. These were high in carbon and usually containd tungsten and chromium, the latter having replaced the manganese of the original Mushet air-hardening steels. Later, the tungsten content was frequently replaced by molybdenum. An air-hardening steel largely used had the following analysis: carbon, 1.75 to 2.00 per cent; molybdenum, 3.75 to 4.25 per cent; chromium, 3.75 to 4.25 per cent.

In the earlier years of the twentieth century, high-speed steels quickly displaced the air-hardening steels. Most of the manufacturers confined their efforts to tungsten-chromium combinations, but in America determined efforts were made to use molybdenum insted of tungsten. At the time that one European metallurgist was claiming that steel containing over 6 per cent molybdenum could not be rolled, we were commercially rolling large quantities of a steel containing over 9 per cent molybdenum and had successfully rolled steel containing up to 15 per cent. The use of molybdenum above 6 per cent was patented, [2] as was the use of vanadium with either tungsten or molybdenum in high-speed steel.[3] So far as molybdenum was concerned, the manufacture of these steels was discontinued almost before the patents had been allowed. One of these patents has now expired, but "discoveries" of chrome-molybdenum-vanadium steel and molybdenum-vanadium steel for high-speed purposes were recently announced. Both of these types of steels were made and abandoned nearly twenty years ago, as they weer found, after very exhaustive experiments and tests, to be unsatisfactory both to manufacturer and in use. Occasionally these steels gave extraordinarily good service, as measured by the standards of that time, which were much below the present standards of the leading high-speed steels. However, notwithstanding the discouraging results of the earlier experiments, the writer has felt that some time we should have to use molybdenum, due to shortage of tungsten, or for other economic reasons, and from time to time during the past twenty years we have repeated our experiments in the art of manufacture. This helped us to overcome the earlier difficulties and objectionable features.

Principal Difficulty With Molybdenum in High-Speed Steel

One of the principal difficulties with molybdenum in high-speed steel is its tendency to volatilize at the high temperatures necessary in the working and hardening of the steel. Indeed, it is possible to detect high molybdenum steels under the hammer by the light yellow smoke arising, which is probably due to the oxide of molybdenum.

After prolonged or excessive heating, a well-defined zone on the outside of the bars or tools is entirely different from the interior in structure, and as a result, finished tools, such as drills and cutters, which cannot be given the grinding permissible with lathe tools are not satisfactory; this has greatly limited the use of molybdenum high-speed steels. Both vanadium and cobalt have been tried in an endeavor to overcome this difficulty. Recently it was stated that cobalt and vanadium are "stabilizers" for molybdenum, but the writer has seen

*Paper read at the New York meeting A. I. M. E., February, 1921.
†President, Crucible Steel Co. of America.
[1] *Bull.* Soc. d'Encourage. l'Ind. Natle. (January, 1898).
[2] C. H. Halcomb: U. S. Pat. 722,504 (March 10, 1903).
[3] J. A. Mathews: U. S. Pat. 779,171 (Jan. 3, 1905).

no evidence to confirm these claims. On the other hand, molybdenum high-speed steel containing either or both of these elements has shown the defect in a marked degree. Some experiments now in progress promise more satisfactory results but it has not been determined whether our "stabilizer" in any way impairs the cutting qualities.

Development of Molybdenum Steels

Cobalt-molybdenum-vanadium high-speed steel was made and abandoned in America before the beginning of the European war, for it was found inferior to the regular tungsten-vanadium steel products with or without cobalt. After reading recently that cobalt-molybdenum-vanadium high-speed steel was the latest foreign contribution to tool-steel metallurgy, some of the cobalt-molybdenum-vanadium material made in 1914, some ingots made along similar lines in 1919, and some of the European steel were used in exhaustive and carefully conducted tests made by the Halcomb Steel Co., in which the leading brands of American and foreign manufacture were used. The molybdenum products failed to give satisfactory results and were rated much below the standard tungsten high-speed steels on the market today.

For the modern developments in the use of molybdenum, we are greatly indebted to C. Harold Wills, of Marysville, Mich. Having become convinced that there was abundant ore in this country, he experimented with molybdenum in a great variety of combinations. Much has been published regarding the physical properties and suggested types of molybdenum-alloy steels but we would refer to the papers by Dr. George W. Sargent,[4] J. D. Cutter[5] and Charles McKnight, Jr.,[6] the booklet entitled "Molybdenum Commercial Steels" by the Climax Molybdenum Co. and the booklet of the Crucible Steel Co. of America entitled "Almo Steels." While much of this material is propaganda, it is based on experiments made in our own laboratories and plants, in those of the Carbon Steel Co., United Alloy Steel Co. and by Messrs. Wills and Chandler, formerly with the Ford Motor Co. The paper by Dr. Sargent refers to the work of Guillet, Saladin, Swinden and Giolitti in reference to prior use and manufacture of chrome-molybdenum steels of somewhat similar types to those in which interest is now centered. Mr. Cutter's paper proposes the use of a merit index for the comparison of different steels, and makes use of a formula in which the elastic limit, ultimate strength, elongation and reduction are all taken into consideration. A similar suggestion appears in the booklet "Almo Steels," in which the formula is limited to the tensile elastic limit and reduction of area.

In the mills, molybdenum steel has been found to work satisfactorily, being relatively as free from seams and similar defects as the older types of alloy steels; it is also freer from thick and tenacious scale than are the nickel and chrome-nickel types. It seems to flow readily, particularly in drop forgings, and can be worked over quite a wide range of temperature, say, from 2,100 to 2,500 deg. F. (1,150 to 1,370 deg. C.), though the higher temperature would not be recommended for steel above 0.25 to 0.30 per cent carbon.

The steel seems to have a wide safe heat-treatment range, as measured by static tests. But it is not advisable to stress this point as it leads to carelessness in heat treatment. In addition, it has been found that static tests are somewhat misleading in this regard. While many steels of high quality can be forged or heat treated through a considerable range of temperature without apparent loss in static qualities, dynamic or shock tests seem to indicate that for every steel there is a temperature at which the maximum of static and dynamic qualities are obtained. Shock-test methods in this regard are of especial value in supplementing our knowledge of materials or even in detecting faulty heat treatments that static tests do not show. Molybdenum steels seem to machine more readily at a given Brinell hardness than do other steels. This would mean, of course, that parts that must be heat treated and machined afterward could be utilized in a state showing higher physical properties than have been customarily obtainable. The physical property on which molybdenum seems to exert most effect is the reduction of area, which is considered a good measure of toughness.

Influence of Molybdenum in Alloy Steels

Molybdenum, particularly in conjunction with chromium, seems to confer the property of deep hardening. This is to be expected from the observation that molybdenum steels resist the drawing temperature to quite an unusual degree. In other words, they require a higher drawing temperature to reduce the physical properties by the same amount that they would be reduced in similar steels without the presence of molybdenum. This indicates that molybdenum tends to keep the carbon in steel in the combined or martensitic form, and when in that condition to retard its passage to the sorbitic or troostitic state. Some years ago the writer sent to Prof. H. C. H. Carpenter,[7] then at the National Physical Laboratory of Great Britain, a chrome-molybdenum steel together with a variety of commercial high-speed steels for use in his investigations upon the drawing or softening of hardened high-speed steels. This particular steel contained but 4 per cent of molybdenum, 3 per cent of chromium, and about 0.47 per cent carbon, yet it resisted the draw-back temperature, as measured by Prof. Carpenter's etching method, to a greater extent than any of the commercial tungsten high-speed steels used by him, whether of American or British manufacture.

It is possibly too early to make predictions, but the writer believes that molybdenum has established for itself a permanent place among the alloy steels found useful to the airplane, automobile and general engineering trades. It will not wholly displace any other type of steel, but the effect of improvements of this kind and new products has been rather to extend the field of usefulness than to eliminate products of previously demonstrated merit. The bessemer and open-hearth processes, and the electric furnace have not displaced the original crucible cast steel business. The demand for steels made by each method has arisen with the process itself.

Not only does molybdenum below 1 per cent give no trouble from volatilization, but it may be recovered from scrap when remelted in the open-hearth furnace to a large extent.

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[4] "Molybdenum as an Alloying Element in Structural Steels," Amer. Soc. Test. Mat. (1920).

[5] "Suggested Method for Determining Comparative Efficiency of Certain Combinations of Alloy Steels," *Trans.* Amer. Soc. Steel Treat. (1920) vol. 1, p. 188.

[6] "Molybdenum Steels," *Trans.* Amer. Soc. Steel Treat. (1921).

[7] H. C. H. Carpenter, Tempering and Cutting Tests of High-Speed Steels," *J. Iron and Steel Inst.* (No. 3, 1906), vol. 71, p. 377.

Legal Notes

By Frederic Dannerth, Ph.D.*

Legal and Official Chemistry

In modern chemical organizations considerable attention is being given to the centralization of the work pertaining to legal and official chemistry. This makes it possible for the executives of a corporation to obtain information quickly when a problem arises. In order to accomplish this purpose it is desirable to have on hand all the literature of importance which pertains to this phase of laboratory work. This includes the *Patent Office Gazette*, the *Treasury Decisions* (of the U. S. Custom House), the *Quarterly* of the National Fire Protection Association, the *Reports* issued by the State Boards of Health, *Transactions* of the Safety Institute of America and the *Rulings* of the Interstate Commerce Commission regarding transport of hazardous chemicals.

The data which are accumulated should be grouped, arranged by subjects and indexed so that they can be brought to the notice of department managers soon after they appear in print. Special attention should be given to patent infringement suits, and court decisions concerning them should, if of local interest, be brought to the attention of each department manager.

If the corporation is about to enter suit, or if it has been sued, it is important that all possible facts relating to the case be collected, so that they may be critically examined. The testimony of the chemist should be carefully prepared so that it may be skillfully presented. Among the commonest forms of law suits are those which arise from breach of contract. Before preparing testimony, the chemist should study all the processes through which a product has passed before it was sold and found to be defective. If for example a vendor has contracted to deliver "best quality rubber jar rings" to a food-canning company, but actually delivers a low-grade jar ring, all the food conserved in jars with the defective jar rings may spoil soon after it leaves the food factory. Here is a case with many possible complications.

Custom House Practice

In cases where imported products compete with the products of his own corporation, the legal chemist should study the methods used for classifying this imported merchandise according to the U. S. tariff act now in force. He must keep in mind that the meaning of words used in the tariff act is interpreted by the federal courts, and not by expert witnesses. An expert witness may, however, testify to the meaning of words, "as they are used in the trade." He should study the meaning of such terms as unmanufactured article, unenumerated, specific duty, ad valorem duty, similitude, component part of chief value and "products not otherwise specified." He will in the course of his studies find that the person who levies duties on merchandise imported at New York City is officially known as the Collector of Customs of the Port of New York. If the duty levied is unsatisfactory to the importer, he may "protest" and appeal to the U. S. Board of General Appraisers for a consideration of his case.

Custom House Cases

Pontianak or *Jelutong*. The protest of L. L. Littlejohn & Co. against the assessment of duty by the Collector of Customs was filed in 1917. This material had been assessed for duty as an unenumerated, unmanufactured article, but the importer claimed that it was known in the trade as rubber and therefore should be admitted duty free under the tariff act of 1913. The protest was heard before the U. S. Board of General Appraisers, and it was shown to the U. S. Assistant Attorney-General that pontianak is not rubber and is not known in the industry as rubber. However, owing to the stress of the war period, the Government did not push the case and the material was finally admitted duty free. (*Treasury Decisions* 37,284 of July 26, 1917, and *Treasury Decisions Abstract* 41,775 of Jan. 31, 1918.

Balata Belting. In the case of Robins vs. United States, before the U. S. Court of Customs Appeals, it was decided Feb. 1, 1911, that balata is india rubber by similitude.

Reclaimed Rubber. In the case of United States vs. Michelin Tire Co., before the U. S. Court of Customs Appeals, it was decided, April 24, 1911, that reclaimed rubber is not a manufactured article.

Occupational Diseases

The investigation of health hazards has been taken up by many of the states through their Boards of Health and is intimately related to the workmen's compensation laws. The duty of the chemist in charge of legal work is then to investigate the special health hazards present in the factory. These may be due to:

1. Overheated rooms.
2. Bad ventilation in rooms where volatile solvents are used.
3. Absence of suction drafts in rooms where powdered minerals are used.
4. Defective ventilation in rooms where poisonous liquids or gases are handled.
5. Bad water drainage in rooms where large quantities of water are constantly spilled out on the floor.
6. Defective flues in rooms where corrosive acid vapors are used for etching, plating or vulcanizing.
7. Absence of suction drafts in connection with lathes or buffing wheels, where fine powders or dusts are formed.

The bulletins on industrial accidents and hygiene published by the U. S. Department of Labor contain a great deal of valuable information on this subject.

Fire Hazards

The legal chemist should collect and file data on fire hazards in factories due to improper storage or use of combustible gases, liquids or solids. For example: In one case it was found that a barrel of chlorate of potash had been stored in a dyehouse, without any label indicating its contents and without any danger signals. When a workman attempted to open the barrel with a hammer and chisel, the chlorate exploded, doing considerable damage to the plant. In another case ground waste rubber was stored in a wooden barrel while still warm from the grinders. Six hours later the material suddenly burst into flame. In the process of coating fabrics with rubber cements a special fire hazard is presented, as large volumes of gasoline are evaporated in a short

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*In presenting this paper the author feels that he has given only an outline of the possibilities in this field. Although he has used this plan in his own work for some time, he feels that the idea of grouping all these subjects in one section under the supervision of a special chemist is relatively new.

space of time. The spreading machines must therefore have careful supervision, and steam jets must be stationed so that they can be put in action quickly.

Transportation Hazards

In the section for legal and official chemistry there should be on file information concerning the risks to which merchandise is exposed while in transit. This may be due to improper loading of freight or express cars; to negligence on the part of employees; to the elements, such as hot weather, cold weather, rain or ocean water. In one case it was found that kitchen ranges made of iron had been placed in a freight car directly next to a barrel of bleaching powder (chloride of lime). The chlorine which emanated from the barrel of bleach during a period of rain attacked the iron and detracted from the value of the stoves. In such cases the "common carrier" may contend that the shipper should mark his package with danger tags, but on the other hand it must be considered that the bleaching powder and not the stove was the real offender. In such instances a careful judge might hold that the "carrier," which in this case was the railway company, must inquire into the contents of all sealed packages delivered to him. This would enable him actually to sort out packages which may cause fire or other damage while in transit.

In one case a cargo of goat skins from the Levant was damaged on shipboard because the hatch had not been closed during a severe storm. As a result of this the salt sea water washed in over the skins, and in that way their value was impaired.

Accidental Poisoning

In many factories which use chemicals in their processes there are some chemicals which lie around unprotected because they are so commonly used. This in some cases has led to accidental poisoning because of the similarity in name of two substances, one of which was harmless and the other harmful. For example: In one case a workman in a dyehouse was preparing a refreshing drink for a hot summer day. He wanted to mix in some cream of tartar, but accidentally used "tartar emetic," which is a distinct poison. In such cases error should be guarded against by carefully branding all chemicals which are in the class of poisons. Workmen should likewise be cautioned against the careless use of such chemicals as sugar of lead, bichromate of potash and aniline oil. These chemicals are so often exposed in large quantities that the workmen become careless in handling them if not cautioned.

Air and Stream Pollution

Most of the industrial states now have enacted statutes governing the pollution of streams with factory wastes. It is therefore desirable to have on file all the recent state laws relating to this subject, as they may affect the dumping of factory effluents into the stream near the factory. In the State of New Jersey it was found about ten years ago that the Passaic River was gradually being converted into an open sewer by the factories situated on its banks. To prevent this from becoming worse, an arrangement was finally made whereby a certain percentage of effluents will ultimately pass out into the open sea through a concrete sewer 20 ft. in diameter.

As an example of air pollution it may be of interest to cite the case of a plant making sulphuric acid in rotary burners. This plant purchased power from a public utilities company, and one afternoon the power was suddenly shut off, due to a storm. This interfered with the process of manufacture in the sulphuric acid plant in such a way that dense fumes of sulphur dioxide suddenly swept over the surrounding district, killing all vegetation. In this case the pollution of the air was not continuous and was not due to any fault in the management of the plant. However, in the case of the smoke nuisance in large cities containing many steel mills, air pollution may become a permanent health hazard, because it is continuous.

A rather interesting case which grew out of the pollution of a stream is related by Thomas Hancock in his personal narrative published in 1857. When coal gas was introduced in England for the purpose of lighting apartments as well as the streets of towns and cities, the manufacturers of the article found that the tar and other liquid products resulting from the process accumulated upon their hands. By 1800 this had already attracted public attention because the gas companies had begun to dump this "unpleasant and undesirable byproduct" into the rivers. In 1819 Charles Macintosh of Manchester was looking for ammonia to use in the manufacture of cudbear. With this in mind he entered into a contract with the Glasgow Gas Works to receive, for a term of years, the tar and ammoniacal water produced at its works.

In 1823 he had progressed so far with his investigation of the material that he obtained coal-tar naphtha as a distillation product and pitch as a retort residue. He then took out a British patent for preparing a waterproof varnish for cloth, in which he dissolved the pitch in the naphtha and used this to coat the fabric. He also dissolved rubber in the naphtha for similar purposes. The earliest attempts at waterproofing fabrics were in fact made with the use of coal tar and later coal-tar pitch, because many persons at that time were trying to find a use for this product. In the final analysis it was the pollution of the streams which caused these investigators to begin their experiments.

Contract Wording

The chemist in charge of the work in legal and official chemistry should render assistance to the purchasing agent whenever possible. In the case of contracts and specifications for the purchase of chemicals, the wording used should be such that misunderstandings at a later date will be avoided. This is why many corporations usually append to the contract a specification showing the chemical and physical tests which the delivery must meet. Such items as the shape, composition, size and weight of containers should be noted. Attention must also be given to such general laboratory specifications as color; boiling point in the case of volatile solvents; fineness in the case of mineral powders; and moisture content in the case of textile fibers, rubber and other materials containing large and variable amounts of water.

Patents

In order to be of most value a patent should be basic and fundamental. According to section 4,886 of the Revised Statutes of the U. S. it must possess novelty and usefulness. It must not cover, (1) a principle; (2) a property of matter or (3) a result. For this reason it will be well to study the style used in drawing up patents which have stood the test of the courts. It will be found that patents are issued for such things as

chemical processes, chemical products or a composition of matter, machinery used in chemical processes, and the application of a product in the arts to produce new and useful effects. It is important that the student of legal chemistry know the meaning of such terms as priority, interference, validity, abandonment, anticipation, infringement, shop rights and invalid. He should also know what steps are necessary to establish priority for any invention which he or his colleagues may make.

Charles Goodyear discovered that *soft* vulcanized rubber products could be obtained by mixing 6 to 20 per cent of sulphur with crude rubber, whereas Nelson Goodyear, the younger brother of Charles, discovered that if the sulphur be increased 25 per cent or more, he could produce *hard* rubber products. Both inventors were granted patents in the United States for their inventions. Here is an instance where the first inventor did not realize the full possibilities of his discovery.

Special Cases in the Rubber Industry

U. S. patent 3,633 was issued to Charles Goodyear of New Haven, Conn., June 15, 1844, for "improvements in the manufacture of india rubber." This patent was contested in the case of Goodyear vs. Providence Rubber Co. It resulted in a decision for the plaintiff, but the defendant appealed and the case was finally decided in the U. S. Supreme Court in 1870. (See Brodix on "Patent Cases," 1869 to 1872, p. 150; and 2 Clifford, p. 35.) Other patents granted to Charles Goodyear in the same year were Nos. 3,461 and 3,462.

U. S. patent 16 was issued to E. N. Chaffee in 1836, for "improvements in preparing and applying india rubber to cloth." Goodyear obtained the rights to this patent in 1844. The patent was, however, contested in the suit of Day vs. Union India Rubber Co., decided by the U. S. Supreme Court in 1857. A U. S. patent was granted on June 7, 1845, to Day, Tyre and Helm for a "machine for cutting india rubber threads." U. S. patent 9,319 was issued to Charles Goodyear, Oct. 12, 1852, for a "method of making india rubber cloth." U. S. patent 4,047 was issued May 13, 1845, to Nelson Goodyear of Newtown, Conn., for the "manufacture of india rubber fabrics."

A U. S. patent was granted on Jan. 11, 1859, to Henry W. Joslin for "improvements in the treatment of india rubber." This process consisted in mixing rubber with zinc sulphide in place of sulphur. In the case of Charles Goodyear and the New England Car Spring Co. vs. Hiram P. Dunbar and Henry W. Joslin, Goodyear asked for an injunction against Joslin. The case was heard in the U. S. Circuit Court, District of New Jersey, in March, 1859, no injunction being granted.

Thomas Hancock on March 18, 1846, was granted a patent in England for an invention covering the use of sulphur to vulcanize rubber, but his original patent is dated Nov. 21, 1843, and this describes how to change the character of caoutchouc by treating it with sulphur and heat. Hancock was a partner of Charles Macintosh, a maker of waterproof cloths in Manchester, England.

Alexander Parkes of Birmingham, England, on March 25, 1846, was granted a British patent for vulcanizing rubber by means of sulphur chloride. He suggested the use of a solution of sulphur chloride in carbon disulphide of about 1.0 per cent concentration.

The Tire Patents

U. S. patent 554,675 was issued to Arthur Grant Feb. 18, 1896, for "a solid rubber tire for horse-drawn vehicles." After much litigation the patent was declared valid by the U. S. Supreme Court, April 10, 1911. This patent was also involved in the suit of the Kelly-Springfield Tire Co. vs. Diamond Rubber Co. A decision was rendered in this case by the U. S. Circuit Court of Appeals in New York City, March, 1916. In its decision, the court awarded the plaintiffs 5c. per lb. on the total number of pounds of tires made under the infringement by the defendant rubber company.

U. S. Patent 822,561 was issued to Peter D. Thropp of Trenton, N. J., June 5, 1906, for a "method for vulcanizing rubber tires in a mold, using open steam." This is the one-cure process. The patent was contested in John E. Thropp Sons Co. vs. U. S. Tire Co. A decision rendered by the U. S. District Court, Southern District, New York, in 1915, declared the patent invalid. (226 Federal, 941.)

U. S. Patent 578,551 was issued to E. C. Duryea in 1897 for "an improvement in vehicle tires." The validity of this was contested in the case Buffalo Specialty Co. vs. Indiana Rubber & Insulated Wire Co. in the U. S. Circuit Court of Appeals, Seventh District. (334 Fed. Rep., 334.)

The Reclaimed Rubber Patents

U. S. patent 635,141 was issued to Arthur H. Marks of Akron, Ohio, Oct. 17, 1899. The validity of this was contested in the case of Philadelphia Rubber Works Co. vs. Portage Rubber Co. In the U. S. District Court, Northern District, Ohio, April 8, 1915, Judge Charles Clarke presiding, the patent was declared invalid. Another case was that of Philadelphia Rubber Works Co. vs. U. S. Rubber Reclaiming Co. in the U. S. District Court, Western District, New York, June 29, 1915, in which Judge Hazel declared the patent valid. This case was appealed to U. S. Circuit Court of Appeals, Second Circuit, and on Nov. 9, 1915, the patent was declared by Judge Lacombe to be valid. (See Fed. Rep., 225, p. 789; 227, p. 623; 229, p. 150.)

U. S. patent 395,987 was issued to J. K. Mitchell of Philadelphia, Jan. 8, 1889. This patent refers to the reclaiming of rubber from manufactured rubber goods by treating the ground waste with mineral acid under pressure. The textile fibers and a certain part of the mineral matter are thus destroyed or dissolved. In the Marks patent the sulphur is removed from the scrap rubber by treatment with caustic soda under pressure.

U. S. patent 12,983, issued to Beers in 1855, also refers to a process of reclaiming.

The Rubber Sponge Patent

U. S. patent 1,045,234 was issued to G. Willis and B. Felix on Nov. 26, 1912, for a process of making artificial sponges. In the appealed case of Featheredge Rubber Co. vs. Miller Rubber Co., heard in the U. S. Circuit Court of Appeals, Sixth Circuit, a decision of June 30, 1919, declared the patent invalid, and the case was given to the defendants. The case rested upon the distinction between sponge rubber and rubber sponge. In commenting on this suit the judge remarked: "In some patents we find that the real discovery is not disclosed in the patent specifications, the purpose being to get the protection of a patent and at the same time hold back the knowledge which would allow the public to manufacture successfully at the end of the patent term." (See 250 Fed., 255, and 259 Fed., 565.)

Rubber Trade Laboratory,
Newark, N. J.

Electric Heating in Ceramics

By Wirt S. Scott

Industrial electric heating, which began with the melting of iron in electric furnaces, has proved so successful that its application has spread rapidly. Almost every industry that uses heat is a logical plant for electrical heating, and the glass industry is therefore affected. In fact, many installations have already been made for the treating of glassware.

A 72-kw. furnace is used for annealing glassware, at a temperature of 1,200 deg. F. This furnace is 22 in. wide, 10 ft. long and 5 ft. high, of the overhead conveyor type.

In one test, several thousand goblets were annealed, the goblets being placed in metal containers consisting of nine trays, each tray holding twenty-five goblets, five per row and five rows deep.

Results of the Test

Sixty-five goblets were selected at random during the test, care being taken to select them from different parts of the furnace and were tested in a spectrometer. Sixty-four showed absolutely no refraction of light rays and were passed as A1 grade. One goblet had almost imperceptible refraction of light rays and was therefore rated in this test as B1. The physicist making the test stated that compared with their general run of product this one goblet would ordinarily have been A1 grade. In their natural-gas-fired annealing ovens they have very few strictly A1 grade, a majority being B1 grade, but a quantity also of C1, the lowest possible grade.

All glasses passing through the furnace were bright polish finish. Glasses through the natural-gas furnace have a slight blue finish. Manufactured gas presents a deposit greater than natural gas. Fuel oil deposits a decided white powder finish necessitating washing and polishing, and is therefore prohibitive.

Fusing Bifocal Optical Lenses

The work of fusing bifocal optical lenses must be done at a very critical temperature, besides requiring a uniform temperature to prevent resulting strains and a clean atmosphere to prevent spoiling the polished faces of the lenses that are being fused. The lenses are placed on small plaques, four per plaque, and each plaque is covered with a vitreous enameled steel square cup, and fed automatically through the furnace chamber and discharged into an annealing oven. The furnace chamber is in four sections, two sections 18 in. long, each maintained at a different temperature. The annealing oven is 60 ft. long.

When the work was carried on originally through gas-fired furnaces the loss was approximately 20 per cent, whereas the average loss is 3 to 4 per cent when electrically treated.

Vitreous Enameled Kitchen Ware

Tests were made to determine the practicability of using an electric furnace for vitreous enameled kitchen ware. Thirty-six miscellaneous pieces were fired in the furnace, and a most careful inspection showed that the results were perfect as to polish, absence of pitting, and general smoothness. Due to the ease with which a definite temperature could be maintained it was a very easy matter to get results of the highest order with almost no attention.

Industrial Heating Section,
Westinghouse Electric & Manufacturing Co.

Belgian Experiments on Palm Oil As Motor Fuel

A series of experiments begun in 1914, but interrupted by the war, has recently been resumed in Brussels on the use of palm oil in internal-combustion motors, announces Trade Commissioner Cross. The question of motor fuel in the Belgian Kongo is a serious one, since a ton of crude oil delivered at Kinshasa in metal casks has an estimated price of 2,000 fr., as against 1,050 fr. in Brussels. Palm oil, on the other hand, costs on the native market an average of 25 centimes per kilo, but varies in price between 8 and 40 centimes. The calorific power of palm oil is from 20 to 25 per cent less than that of crude oil, so that a relatively large consumption of palm oil must be reckoned with, while the comparatively high temperature at which palm oil fuses (37 deg. C.) indicates the possibility of rapidly clogging the motor.

Complete Combustion Necessary to the Utilization of Palm Oil

According to engineers closely connected with the experiments, without constructing a special palm-oil motor it was necessary to find a machine in which complete combustion is assured by a complete vaporization of the fuel, which should be introduced in a quantity strictly proportionate to the load. It was further essential that the gaseous mixture should be constant and capable of regulation by a supply of water, varying according to the load and the amount of oil being fed in. Thorough clearing of the exhaust gases was also a requisite.

Tests Proved Satisfactory

The Belgian colonial company Omnium Africain has been successful in finding a two-cycle semi-Diesel motor of Swedish manufacture developing 10 hp. at 500 r.p.m. which satisfies these conditions, and motors of larger and smaller sizes of the same character have been run on palm oil with good results without special changes for the use of the new fuel. The palm oil, which at normal winter temperature in Belgium has about the consistency of soft butter or lard, is placed in a tank divided into three compartments by wire screening. As this tank is heated either through the circulation of hot water from the cooling system or other mechanical means, the palm oil liquefies and passes through the screening to the feed pipe leading to the injection pump. For experimental purposes this motor is started on crude oil. Once it has warmed up, and as soon as the palm oil begins to liquefy, the crude oil is turned off, so that the engine then runs on palm oil exclusively with no slackening of the number of revolutions or of the power produced. At the temperatures prevailing in the Kongo, engineers claim that this motor could be immediately started on palm oil, and it is proposed to install motors of this type on launches and other small river craft, as well as to conduct further experiments for their use in industry and traction. Analysis shows that there are no incombustible components in palm oil, and, contrary to general expectation, the oil neither clogs the motor nor leaves any perceptible solid residue behind it.

Will Simplify Fuel Problem

In case further development of this fuel proves practicable, it will simplify the fuel problems not only of the Belgian Kongo but also of other colonial domains remote from mineral fuel, and where the use of wood only entails much extra labor and other difficulties con-

nected with the various heating capacities of the woods used, to say nothing of the risk of indiscriminate deforestation. The French Ministry of Colonies has conducted experiments with peanut oil, and in July, 1920, the Belgian Ministry of Colonies announced a competition of tractors run on vegetable oils produced in the Kongo, but only one contestant put in an appearance.

The Elaeis palm, from the pulp of the fruits of which this oil is extracted, grows in Africa from Senegal to Angola in a north and south direction, and east to the great lakes. The oil of this tree has been heretofore exported from the Gold Coast, Sierra Leone, Nigeria, Guinea, the Ivory Coast, Dahomey, Togoland, Cameroon, Angola and the Belgian Kongo.

Composition of the Oil

According to analyses by Belgian chemists, palm oil is a mixture of palmitate and oleate of glycerine, with some variable quantities of palmitic and oleic acid. It contains about 95 per cent of fatty acids and appears as a pasty substance of yellowish or salmon color. Its calorific power is estimated at 9,228 calories (Berthelot-Mahler), and it is flammable at 210 deg. C. It thus possesses the advantages of being widely grown and easily obtainable, of large calorific power in small volume, of safety in handling and of having no damaging effect on machinery in which it is used.

Synopsis of Recent Chemical & Metallurgical Literature

Manufacture of Linseed Oil.—An excellent illustrated review of the modern technology of linseed oil manufacture was published in the Jan. 5, 1921, issue of *Paint, Oil and Chemical Review* by permission of the William O. Goodrich Co., Milwaukee. The raw material is flaxseed or linseed, the seed of the flax plant. When fibers for use in the manufacture of linen are desired, the flax must be harvested before the seeds are ripe enough to yield a good grade of oil. Thus raising flax for linen and for oil are separate undertakings. Argentina, the United States, India, Russia and Canada are the leading flaxseed producers in the order given. Their combined output has fallen from a maximum of 150,000,000 bu. in 1912 to an average to 50,000,000 bu. for the last four years.

Linseed contains from 33 to 40 per cent of oil, but the actual yield of oil varies from 26 to 35 per cent. The oil may be obtained by three processes: Hot-pressing, cold-pressing and extraction with volatile solvents. The first of these—known as the "old process"—is used almost exclusively in this country. After cleaning, the linseed is passed through 5-high chilled crushing rolls the function of which is not to express the oil but simply to break down the structure of the kernel to a flaky condition. This assures a stratified cake with a minimum resistance to the flow of oil in the press. The ground seed is carried by screw conveyors to jacketed kettles, where it is heated to about 180 deg. F. in order to soften the oil cells and decrease the viscosity of the oil. A hydraulic cake-former molds the meal into proper size and form to fit the press boxes. Sufficient pressure is exerted in the former so that the hydraulic presses can be built of an economical working height without sacrificing capacity. In order to hold the cakes in the press and prevent them from squeezing out, haircloth is wrapped around the meal. Pressure control in the presses is automatic and after about an hour the cakes are removed to automatic trimming machines, where the oily edges are removed and returned to the process. The cleaned cakes are sold for cattle feed or fertilizer. The raw oil is settled to remove foots, filtered, and is then ready for sale as such or it may be converted into boiled or refined oil. As a rule, boiled oil is made at present from raw oil by the addition of red lead and manganese driers, by expelling the moisture and by bodying the oil to the desired gravity. The refined oils are many in number to meet the exacting requirements of the trade.

While the paint grinder is still the largest consumer of raw linseed oil, there is a constantly growing demand from makers of foundry core oils, putty and linseed oil soaps. Boiled oil is used largely as a ready-mixed paint vehicle, though lesser quantities are consumed in the manufacture of window-shade cloth and similar fabrics.

The refined oils may be classified according to use as grinding oils, varnish oils, and oils of the blown or oxidized type. Refined linseed oil in some form or other is used chiefly in the manufacture of paints, varnishes, enamels, linoleum and oilcloth, patent leather, oiled clothing, imitation leathers and printing inks. It has no value as an edible oil, an illuminant or a lubricant. A discussion of the use of metal containers instead of cooperage, an outline of methods of analysis and a glossary of technical terms conclude the article.

Note:—The following data, compiled recently by the Tariff Commission, form a logical supplement to the above review of the industry:

Domestic production of flaxseed for 1912-1916 averaged 15,000,000 bu. of 56 lb. North Dakota, Minnesota, Montana and South Dakota produce the bulk. Imports in 1918 were 12,785,034 bu. valued at $33,830,735. Exports are relatively insignificant, 21,481 bu. in 1918, mostly going to the United Kingdom and Canada. In 1919, domestic production of linseed oil amounted to 224,627 tons (59,900,000 gal.) obtained from 678,903 tons of flaxseed. Imports since 1912 have been less than 0.3 per cent of the production in this country. Since 1914 the exports of linseed oil have been about 1,200,000 gal. per year.

Selenium Chloride.—In the January number of the *Journal* of the American Chemical Society (vol. 43, p. 29) there is a very interesting note on selenium oxychloride by Victor Lenher. It may be recalled that when Dr. W. R. Whitney received the Perkin Medal this year he said in his address on "The Biggest Things in Chemistry," "and so I note such researches as Prof. Lenher's on selenium oxychloride, and I say to myself, 'Watch it grow!'"

The present paper contains a great deal of information of which we repeat some of the high lights. It is slightly yellow, transparent to visual light, but so opaque to ultra-violet that it makes practically a screen for all wave lengths below 4,050. It is miscible in all proportions with carbon tetrachloride, chloroform, carbon disulphide and benzene. With saturated aliphatic hydrocarbons at ordinary temperatures there is apparently no chemical reaction, or if there is any it is very slight. The unsaturated hydrocarbons of the same series, on the other hand, unite with selenium oxychloride directly, frequently with the manifestation of great energy. Amylene, for instance, reacts with it with great violence, and with such hydrocarbons as turpentine the reaction is like that of halogens on turpentine. It is thus possible to separate such unsaturated aliphatic hydrocarbons as amylene from the saturated heptane by simple contact with this solvent. Again, if a mixture of heptane and benzene is treated with it, the benzene goes into solution, while the lighter heptane rises to the top and forms an immiscible layer.

Sulphur, tellurium and selenium dissolve with ease in the cold liquid; most metals react with it, forming the chloride of the metal and red-brown selenium chloride. It dissolves many metallic oxides, and solutions of molybdenum trioxide and the pink carbonate of cobalt show remarkable photochemical reactions. With carbonates its reactions are of considerable variety. Barium sulphate is peptized by it to a gel much resembling freshly precipitated aluminum hydroxide, but the colloidal form of barium sulphate is immediately changed back to the ordinary form when treated with water.

Protein materials, such as hair, bristles, silk and leather, are readily dissolved in the cold. Vegetable and fish oils

behave in a way similar to treatment with sulphur monochloride. With linseed oil it forms a rubber-like mass similar to that produced by sulphur monochloride. Menhaden oil reacts with selenium oxychloride also to form a waterproof rubber-like mass. Rubber reacts chemically with it, and the chemical character is changed in the process. Phenolic condensation products, gums, resins, dried paints, shellac, dried varnish, agar, celluloid, gelatine, glue —including the insoluble casein glue—are all readily dissolved by it in the cold.

Natural asphalts, resins and bitumens dissolve with ease in the cold when they are of unsaturated character. Such a product as ozokerite, which consists principally of saturated hydrocarbons, behaves very like paraffine with it. Natural coals brought into contact with selenium oxychloride react so far as the bituminous and resinic materials are concerned, leaving a carbonaceous residue behind. Thoroughly ignited coke loses nothing with the reagent, whereas incompletely coked soft coal goes partially into solution. Anthracite coal shows little reaction, semi-anthracite loses considerable, and bituminous coals lose a great deal. Lampblack loses its hydrocarbon content, leaving behind carbon.

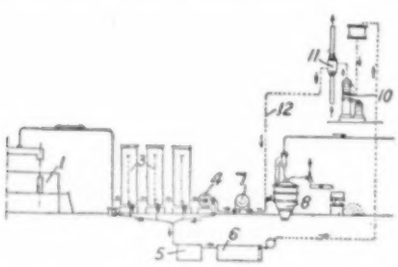
The carbonaceous material separated from iron and steel by the copper chloride treatment consists of graphite and what is believed to be unsaturated hydrocarbons. With selenium oxychloride a black extract is produced which shows that at least a part of the material has been acted on. Further study of this with a view to throwing light on the constitution of iron and steel is advised by Prof. Lenher. It is truly a remarkable solvent.

Recent Chemical & Metallurgical Patents

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

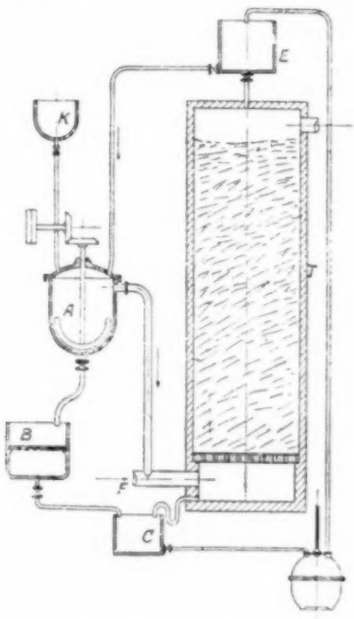
Ammonium Sulphate.—In the "semi-direct" method of recovering ammonia as sulphate from coke-oven gases the hot vapors from the ammonia still are further heated by means of the waste gases from the coke ovens and then mixed with the cooled gases from the tar extractors, the mixture then passing to the saturator; the heat thus supplied prevents dilution of the acid in the saturator by the water present in the gases. Using the apparatus shown, the gases from the ovens 1 pass through coolers 3, a tar



condenser 4 and a tar extractor 7 to the saturator 8; the ammoniacal liquor and tar from the coolers 3 and condenser 4 flow to a tank 5, whence the ammoniacal liquor passes to a tank 6, from which it is pumped to a still 10; the vapors from the still pass through a heater 11, in which they are heated to about 200 deg. C. by the waste heating gases from the ovens, and the heated vapors pass by pipe 12 to mix with the cooled gas on its way to the saturator. (Br. Pat. 153,177; Soc. Franco-Belge de Fours a Coke, Brussels. Jan. 12, 1921.)

Separation of Alkaloids.—Alkaloids are selectively isolated from drugs containing more than one constituent by taking advantage of their varying basicities and their different solubilities in various solvents. The raw alkaloidal material containing more than one constituent, mixed if necessary with powdered vegetable tissue, is acidified and treated with a suitable solvent, whereby the weakly basic alkaloids are extracted, leaving the strongly basic alkaloids fixed in the tissue. Further vegetable tissue is then added to the concentrated extract and the weakly basic alkaloids fixed thereto by the addition of acid. By a choice of solvent, one alkaloid can be extracted from all the remainder. The isolation of morphine from opium and the separation of the remaining alkaloids into weakly and strongly basic components are described in the example. Alkaloids of the narcotine group comprise the weakly basic components. (Br. Pat. 153,219; Chemische Fabrik vorm. Sandoz, Basel, Switzerland. Jan. 12, 1921.)

Dinitrophenol.—Phenol is nitrated at 95 deg. C. with dilute nitric acid, which is fitted for further use by addition of strong acid from a nitrogen oxides absorption tower. The phenol is fused in a vessel *K* and nitrated in a vessel *A* fitted with a stirrer, the nitrous gases evolved being absorbed by dilute nitric acid in the tower *T*. The dinitrophenol is then collected on the filter *B* and the spent acid, after



mixture in the tank *C* with strong acid from the tower *T*, is forced to the vessel *E*, which supplies the nitration acid and the absorption acid. The nitric acid content of the system is maintained by introducing fresh nitrous gases by the pipe *F*. (Br. Pat. 153,265; not yet accepted; Norsk Hydro-Elektrisk Kvaelstofaktieselskab, Christiania, Jan. 12, 1921.)

Catalyst for Synthetic Ammonia.—A catalytic material, for use in the synthetic manufacture of ammonia under conditions of super pressure, consists of an oxide of iron, approximating in composition to Fe_3O_4, prepared by directing a jet of oxygen on to molten iron monoxide. A small quantity of lime may preferably be incorporated in the product. A bar of iron or steel is fused under a jet of oxygen and the molten product, which consists of iron monoxide mixed with iron, is collected in a crucible preferably of magnesia. At this stage 5 to 10 per cent of lime may be added, together with a small amount of alkaline oxides. The jet of oxygen is then directed upon the molten mass, whereby large quantities of heat are evolved, the mass becomes agitated, and the lime is dissolved in the oxidized melt, as well as some of the magnesia of the crucible. The treatment is continued until the mass is completely homogeneous, or if impurities are present, until the surface begins to congeal, when the product is cast on a sheet of iron. Specification 130,086 is referred to. (Br. Pat. 153,254; not yet accepted; Soc. L'Air Liquide—Soc. Anon. pour l'Etude et l'Exploitation des Procedes G. Claude, Paris. Jan. 12, 1921.)

Current Events
in the Chemical and Metallurgical Industries

Tariff Hearings on Chemical and Metallurgical Products

In framing the new tariff bill, the Committee on Ways and Means of the House of Representatives has been asked by representatives of the chemical glassware industry, the chemical porcelain industry, and by representatives of the manufacturers of scientific apparatus to eliminate the duty free clause on such materials which are intended for educational or scientific purposes. It was contended that 50 per cent of the chemical porcelain imported comes in duty free under this paragraph. Since the last hearing on this subject, the opinion of students has been consulted and it is found that a large percentage of them favor paying a slightly higher price for their apparatus so as to encourage an American industry. It was testified that the domestic industry cannot hope to expand if it cannot undertake quantity production. To do that it must have the full market rather than 50 per cent of it, it was stated.

In connection with this item, Dr. Charles H. Herty was asked this question by Representative Garner: "How is it that the German people can pay $2,000,000,000 a year taxes to a foreign country, pay 12 per cent export duty, and still be able to destroy their competitors throughout the world? What I cannot understand is how some people are so superior to other people that they can come over here and put our commercial people out of business." In his reply Dr. Herty stated that the practice is to sell articles below cost until competitors are destroyed and then advance prices to the very limit, thus recouping losses. In addition, he said, the exchange rate offsets some of the disadvantages against which the Germans must contend.

Phosphorus

A duty of 18 cents a pound on phosphorus has been asked by C. W. Asbury of the American Phosphorus Company. This is the old Payne-Aldrich rate. If it were not for the difficulties of transportation, Mr. Asbury declared, a much higher rate would be necessary to enable an American manufacturer to compete with foreign producers.

The witness introduced a letter from General Fries of the Chemical Warfare Service to the effect that phosphorus is a most essential commodity for the prosecution of war and that the country should be independent of foreign sources of production. Mr. Asbury testified that the plant of his company at Philadelphia is the only one in the United States and that it has been closed since November 1 because of inability to compete with foreign producers. He stated that the annual peace-time consumption of phosphorus in the United States is 1,000,000 pounds. In addition to the use of phosphorus in the making of matches, it is used in quantities in the manufacture of phosphor-bronze bearings and as a substitute for camphor in the manufacture of celluloid articles. Small quantites are used in laboratories and as drugs. The military uses of phosphorus, Mr. Asbury testified, are to create smoke-screens, in the manufacture of range-finding bullets, and in chemical warfare.

Ferromanganese

Ferromanganese will be dutiable at two cents a pound if Congress should approve the rate requested by E. G. Lavino and other ferromanganese manufacturers, who appeared before the Committee, and testified that this rate is necessary to protect the domestic industry against the very aggressive competition afforded by English manufacturers. It was stated that the English manufacturers have formed a pool and that it is its deliberate intention to wreck the American ferromanganese manufacturing industry.

These witnesses pointed out, however, that should a duty be placed upon imports of manganese ore, it would be necessary to increase accordingly the rate of duty asked on ferromanganese. They are not opposed to some degree of protection for the domestic manganese mining industry but it was very apparent that this position was taken simply to avoid the inconsistency of urging protection for their products while at the same time asking that the product of another industry be placed on the free list. Mr. Lavino stated that there is not a sufficient quantity of manganese ore in the United States to permit of any great development of manganese mining while at the same time deposits are of poor quality and at a distance from the points of consumption.

Arsenic

Arsenious acid and arsenic acid are now on the free list. Congress has been requested to place a duty of five cents per pound on these articles and a proportionate rate on the arsenic content of Paris green and London purple, in the interest of the domestic arsenic industry. An ad valorem duty of 20 per cent is asked for other arsenical compounds. The Committee was also advised that a modern plant for the manufacture of white arsenic just has been completed at Toulon, Nevada.

Continuance of Work at Wilson Dam and Muscle Shoals

During a hearing on the item in the Sundry Civil Bill calling for $10,000,000 for the continuation of the work on the Wilson dam, the proposed operation of the nitrate plants at Muscle Shoals was discussed at length. One of the important developments was a statement by Colonel Hugh L. Cooper, who is acting in a consulting capacity with the Corps of Engineers, to the effect that it would defeat the power plan if the first 80,000 horsepower of secondary power were used to operate the nitrate plant. In that connection, Colonel Cooper said:

"Such a first use of 80,000 horsepower secondary power would defeat my power plan. The first 80,000 horsepower secondary power will produce 446,000,000 kilowatt hours for an average period of slightly over 10 months per year. Compare this first 80,000 horsepower with the last 80,000 horsepower of secondary power. The last 80,000 horsepower of secondary power will produce an average of only 172,000,000 kilowatt hours for an average period of 4 months per year. Power that is good for 10 months per year is worh at least 33⅓ per cent more per kilowatt hour than the same kilowatt hour power that is good for 4 months per year. I feel quite certain that the taking away from the secondary earning capacity in my plan now before you of the first 446,000,000 kilowatt hours per annum would be taking off so much of the cream of this business as to make the remaining skim milk not worth building transmission lines for. Transmission lines cost practically the same whether used 4 months or 12 months of the time per year."

Colonel Cooper stated that the development can be made a paying one, provided it is confined to power. In addition to saving $9,500,000 a year to the consumers of power within a radius of 250 miles of Muscle Shoals, he has submitted figures showing that the government can make 5 per cent on its investment after the project is complete and ultimately get back all of the money invested. In view of the great benefits to be derived from this development, he said it would be a national crime if the work were stopped now and the $17,000,000 invested thrown away.

Dr. Charles L. Parsons appeared in opposition to the operation by the government of the nitrate plant. He dis-

cussed the various processes used in the fixation of atmospheric nitrogen, declaring among other things that the cyanamide process is in a condition of obsolescence and that he does not expect to see it in operation in any country within a few years. He declared that the question of sludge disposal alone would make it very difficult to operate the cyanamide plant at Muscle Shoals, and that such a scheme as proposed by the War Department never would be able to meet its expenses. He called attention to the fact that it will be necessary to build an ammonium sulphate plant at a cost of at least $3,000,000.

Patents for Government Employees

Determined opposition has developed in the Senate against that section of the conference report on the Patent Office bill which authorizes the Federal Trade Commission to administer patents for Government employees. As this is written, it seems likely that the Senate conferees will recede from their demand that this section be included in the bill. Senator Reed of Missouri has stated on the floor of the Senate that the bill cannot become a law at this session, unless that section is eliminated.

The House has accepted the conference report including the Government employees section. The Senate is willing that the salaries in the Patent Office be increased and that the force be enlarged as is provided by the main bill. The Government employees section is a rider on that measure, which was attached in the Senate.

Senator Reed based his opposition to the measure on his belief that the bill would give an unfair advantage to a Government inventor as compared with an outsider who might not have a salary to keep him going. He also objected to the licensing feature of the plan. By right, he said, an invention made by a Government employee should belong to the Government, but to stimulate effort he admitted the advisability of allowing a Government employee to take out a patent. His objection to the bill was that it places them on a different footing than other persons.

Senator Norris of Nebraska, who is supporting the conference bill, declared it would be a step toward protecting the poor inventor against infringement of his patents by powerful interests. He said that it is admitted by all that any poor inventor can be worn out in the courts and his patent infringed with impunity. He accused large interests of suppressing thousands of inventions annually so as to prevent competition in their line or make necessary improvements in their plants, to the great detriment of the public.

Investigation of Sulphur and Phosphorus in Steel

An interesting co-operative investigation on the effect of sulphur and phosphorus in steel has already been described in these columns.[1] Thirteen heats of rivet steel having "residual" sulphur varying from low to quite high were made some months ago by the Carnegie Steel Co., and a comprehensive program of physical tests is now being conducted at the Watertown Arsenal.

In co-operation with the Bethlehem Steel Co. a beginning has been made in the manufacture of material to show the effect of additions of sulphur to otherwise first-class steel. Three heats have been manufactured of steel having carbon contents of 0.18 to 0.22 per cent, 0.35 to 0.45 and 0.65 to 0.75 per cent, typifying roughly plate and structural steels, forging steels, and wheel, tire and rail steels. The steel was made by the regular commercial basic open-hearth practice and each lot was a part of a 45-ton heat. The original sulphur content of each heat was 0.04 per cent or below; more sulphur was added in the form of iron sulphide in a pouring box located between the ladle and the ingot mold. For each carbon content it was aimed to have a series of sulphur content ranging from 0.04 to 0.15 per cent. The object was thus the production of ingots of steel identical in composition in all respects except the sulphur content. Ingots, 16x16x57 in. in dimension were rolled to 4x4 in. billets and then portions of them for test were further rolled to 1 in. rounds, and a portion of the billets rolled also to 1 in. flats, so that material for test can be taken transverse to the direction of rolling. In order to compare the effects of added and residual sulphur it is planned to remelt the discarded portions in two lots, one high in sulphur and one low in sulphur.

An active search is being made for stock material containing abnormal amounts of sulphur and phosphorus which has given good service, or on the other hand, stock material containing normal impurities which has been unsatisfactory. Automobile manufacturers, railroads, and steel foundries are requested to notify the committee (C. L. Warwick, Chairman, 1315 Spruce St., Philadelphia) whether they have material of this sort which would be available for test. So far little or no material of high phosphorus or sulphur content has been obtained, and there seem to be practically no records in the companies interviewed of failures that can be attributed to high phosphorus or sulphur.

[1] CHEM. & MET. ENG., vol. 22, pp. 297, 609, 952.

Philippine Palm Products

Dr. H. D. Gibbs addressed the South Jersey Section of the American Chemical Society at the regular meeting in Carney's Point, N. J., on Wednesday evening, February 16, 1921. His subject was "The Palm Trees and Their Products." The lecture was illustrated with many interesting views taken by the Bureau of Science during the speaker's service in the Philippine Islands. Although there are about seventy-eight species of the palm tree known, there are only five that are of commercial importance in the Philippines, namely, the coconut, nipa, cabonegro, fish-tail, and buri palms. The date palm requires a dry climate and therefore is not found in the Philippines. The coconut palm yields a wide variety of products ranging from nut-butter to thatched roofs. The nipa palm is an important source of alcohol.

Nipa palms can be tapped every year for an indefinite number of years. The flower stalks are cut off, and the sap flows for two to three months. Buri palms can be tapped but once. They grow to a height of 60 to 80 ft., compared with 15 to 20 ft. for nipa palms. The trunk of a buri palm may be over 2 ft. in diameter, and often contains several tons of starch. The top of the tree is cut off, and due to the action of a diastase the sap that flows out contains practically nothing but sugar. During a period of several months all of the starch in the tree is converted into sucrose. The flow of sap then stops and the tree is dead.

The sap from these palm trees analyzes about 15 per cent sucrose. Immediately after it is exposed to the air it starts to ferment, and within a very few hours all of the sugar is converted to alcohol. This occurs while the sap is being transported to the distilleries. The speaker said that by painting the inside of the sap-collecting vessels with a lime-sulphur preparation, he was able to prevent this fermentation, and thus the sucrose solutions could be preserved for several weeks until they could be transported to a sugar refinery. This opens the possibility of converting the palm alcohol industry into a palm sugar industry and promises a very cheap source of sugar.

International Steel Conference Proposed

At a meeting of the directors of the American Iron and Steel Institute held in New York on Feb. 25, the chief topic of discussion was concerning the international aspects of the steel market. A suggestion has been received from steel producers in England, France and Belgium for the calling of an international steel conference of steel makers of all nations active in the trade. The object of such a conference would be discussion of general economic conditions in the industry as well as an interchange of ideas dealing with economies in manufacturing. The matter was referred to Judge Elbert H. Gary in his capacity as president of the American Iron and Steel Institute. It is expected that the plan for the proposed conference will be studied by officials of the Institute and a report made at the spring meeting.

Personal

Dr. RAYMOND F. BACON, director of the Mellon Institute of Industrial Research of the University of Pittsburgh, has returned from Europe, where he spent the holidays in France and Italy in the investigation of nitrogen-fixation processes.

STUART CROASDALE of Denver, Col., announces that he and his associates have opened an Eastern office in the Magee Building, Pittsburgh, Pa., for the purpose of conducting a business in mining and metallurgical engineering. The new organization will operate under the name of Stuart Croasdale & Co., and will maintain a Western office in Denver, Col.

J. V. N. DORR addressed the Cleveland section of the American Chemical Society on Feb. 21 on the subject of "Some Continuous Operations in Chemical Industry."

JUNIUS D. EDWARDS, chief of the physical chemistry division of the research bureau, Aluminum Co. of America, at New Kensington, Pa., has been appointed assistant director of research.

JAMES B. GRAHAM, president of the Northern Central Trust Co. of Williamsport, Pa., has been elected president of the board of managers of the Crescent Refractories Co., Curwensville, Pa.

H. H. HILL has been appointed superintendent of the Bureau of Mines petroleum experiment station at Bartlesville, Okla., succeeding A. W. Ambrose. Mr. Hill was formerly employed as a chemist in the Pittsburgh and Washington laboratories of the bureau and was transferred to Bartlesville about a year ago for work on refining problems.

FRANK HODSON, president of the Electric Furnace Construction Co., Philadelphia, Pa., has been elected a member of the executive committee of the Philadelphia Foundrymen's Association.

N. C. HOYLES has been appointed manager of the Cincinnati branch of the Pittsburgh Testing Laboratory, at 813 Race Street, Cincinnati, Ohio. From 1909 to 1914 Mr. Hoyles was manager of the Birmingham, Ala., branch of this company. In 1914 he joined the Canadian military forces and went overseas with the Canadian engineers. For the past year he has been assistant manager of the Pittsburgh Testing Laboratory's New York office.

W. W. ODELL of Urbana, Ill., has been selected to take immediate charge of the lignite investigation which is being conducted by the Bureau of Mines. The bureau is preparing to conduct experiments on a commercial scale with North Dakota lignite. Mr. Odell, who has been doing coal gas work at the Urbana Station of the Bureau of Mines, has 15 years' experience in this type of work, and has been with the Bureau of Mines since 1917.

Mrs. FREDONIA JOHNSON PRATT of St. Louis, Mo., widow of the late Dr. David S. Pratt, assistant director of the Mellon Institute of Industrial Research of the University of Pittsburgh, has established in that institution an industrial fellowship as a memorial to Dr. Pratt. The incumbent of this industrial fellowship will conduct research in that field of organic chemistry in which Dr. Pratt was especially interested.

EDGAR S. ROSS, who has been doing private research work with Professor C. James, New Hampshire College, Durham, N. H., for the past 18 months, was recently transferred to Philadelphia, and will continue research investigations at the Greenwich Point Laboratories of the Pennsylvania Salt Mfg. Co. Previous to the work at New Hampshire Mr. Ross was engaged as chief chemist and plant supervisor for Charlotte Chemical Laboratories, Inc., and Columbite Reduction Co., both of Charlotte, N. C.

C. W. SUTTON has been re-elected president and general manager of the American Vulcanized Fibre Co., Wilmington, Del., at a recent meeting of the board of directors.

WILLIAM BOYCE THOMPSON received the honorary degree of doctor of laws at the Charter Day exercises of the University of Pittsburgh, on Feb. 18. On the same occasion the honorary degree of doctor of science was conferred upon C. H. MacDowell, president of the Armour Fertilizer Co. and director of the chemicals division of the War Industries Board during 1918. These honors were given upon the recommendation of the Mellon Institute of Industrial Research.

CARL A. WENDELL, chief engineer of the American Ore Reclamation Co., New York, has been retained by the General Briquetting Co. as consulting engineer in flue dust briquetting, coal washing, and coal briquetting.

CHARLES S. WITHERELL, recently on the metallurgical staff of Guggenheim Brothers, has entered private practice as metallurgical engineer at 150 Nassau Street, New York.

Dr. J. C. WITT has been placed in charge of chemical research for the Portland Cement Association. This work is being carried on at the Structural Materials Research Laboratory in co-operation with Lewis Institute, Chicago. For a number of years, as chemist and chemical engineer, Dr. Witt has been identified in various ways with the manufacture and use of cement and other materials of construction.

Obituary

H. B. ROSENGARTEN, for many years one of the most widely known chemical manufacturers of Philadelphia, died Feb. 20 at his home. He was eighty-four years old. Mr. Rosengarten formerly was head of the Powers-Weightman-Rosengarten Co. of Philadelphia. He retired from active business several years ago.

Book Reviews

THE MANUFACTURE OF SUGAR FROM THE CANE AND BEET. By *T. H. P. Heriot*, F.I.C., Lecturer on Sugar Technology at the Royal Technical College, Glasgow. New York: Longmans, Green & Co., 1920. x + 426 pp., 39 figs. Price, $8.50.

Treatises on manufacturing technology usually emphasize either the theoretical or, more commonly, the descriptive side. That this book falls within the former classification may be seen from the opening paragraph of the preface:

> It has often been stated that the sugar producer can only be trained in the factory, theoretical knowledge being of little value. The aim of the present work is to show that successful practice is becoming more and more dependent on scientific principles, which can be studied more effectively outside the factory than inside.

In the plan of the book the manufacture of cane and beet sugar is carried along in parallel chapters, the theoretical treatment usually being followed by some description of the important machinery. While this dual arrangement may appeal to some, the reader who is particularly interested in either branch will be apt to find it more annoying and confusing than valuable. It also leads to some difficulties, as we find the filtration of beet juices discussed in chapter XVIII before the chemical treatment is reached in the following chapter. In the reviewer's opinion, the point more deserving of emphasis is that the sugar technologist should acquire familiarity with the technic of other manufacturing industries; for example, it is only recently that certain improved types of filters have been introduced into the sugar industry which have been standard in metallurgical work for a number of years.

The subject of juice extraction from the cane is thoroughly and interestingly handled, and a good theoretical treatment of the diffusion process for extracting sugar from the beet is given. Mention should be made here, however, of the importance of having battery supply water as low as possible in dissolved solids. The chapter on

evaporation is meager and wholly unsatisfactory. No discussion is given of the value of vapor heating, and the Wellner-Jelinek type of evaporator is not even mentioned. On the subject of crystallization the author is plainly more at home and deserves credit for his treatment of this section. The use of the term "first molasses" is unfortunate, as it is general practice, at least outside of the British Isles, to restrict the designation "molasses" to the final, exhausted mother sirup.

The subject of refining is treated in the last section of twenty-six pages. The author has attempted a good deal in trying to cover the three branches of sugar technology in a book of 400 pages. Under these circumstances it is hardly fair to criticize him for concentrating on the important phases and omitting many details of less importance. In some respects, however, the book could be improved by a more comprehensive treatment of some things and by the omission of others, such as some of the antiquated desugarization processes for molasses.

So many technological works are mere descriptions of processes and machinery that a book which deals primarily with the "scientific principles" is a relief and more than welcome. As such it should offer much stimulation both to the student and to the so-called "practical man." Less can be said for the descriptive matter, which is inadequate except in a few cases. S. J. OSBORN.

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MACRAE'S BLUE BOOK, VOL. XI, 1920. 1855 pages. Chicago: MacRae's Blue Book Co., 1920. Price, $10.

Chemical and metallurgical engineers will find much to interest them in this unusual directory. Its classified material section serves as a buying guide for the wide variety of materials required by any large industrial organization.

In addition to the alphabetical lists of manufacturers and of trade names which are ccommon to directories of this type there are two special sections which serve to round out the usefulness of the book. The first of these is an indexed collection of miscellaneous data including weights and sizes of sheet lead, lead pipe, copper, brass and steel tubing, cast and wrought iron pipe, pipe fittings, wire, sheets, structural shapes, etc. Finally there is a standard list price section (including differentials and extras) covering a multitude of iron and steel products, belting, glass and other plant supplies. The calculation of discounts is facilitated by the use of a table giving the equivalent discount and net price corresponding to the usual trade discounts. This is supplemented by a five-place logarithm table of numbers from 0 to 999. ALAN G. WIKOFF.

Current Market Reports

The Chemical and Allied Industrial Market

NEW YORK, Feb. 25, 1921.

The chemical business in general appeared quiet during the past week and spot material was not moved in very large dimensions on account of the accumulated stocks of important material in the warehouses. A fair amount of miscellaneous inquiries, however, have been filled in the open market, but the major portion of these were for small lots for immediate delivery. Underneath the surface of the market, some of the largest manufacturers have been able to place a good volume of business on contract with their regular trade and this condition holds true of several important lines. Offerings of foreign chemicals have not caused much of a dent in domestic quotations, but have created a feeling of uncertainty among large buyers which tended to retard actual consummation of new business.

Factors close to the heart of trade conditions admit that sentiment is somewhat mixed. In some industries a marked improvement is noted, although indications are still for a period of a hand-to-mouth business based to a large extent, upon immediate requirements. It now seems clear that the process of placing business upon a level fairly comparable with that which prevailed prior to the war is in progress. Precipitate declines in commodity markets seem to be passed. Even with the continued declining tendency normal business at a satisfactory profit is possible.

One of the strongest items in the chemical list was *soda ash*. The relatively small supplies in the hands of dealers and jobbers were fully reflected at intervals and prices were occasionally advanced where buyers needed immediate delivery. Inquiries of carlots from Western consumers kept trading moderately active at well sustained prices which ranged from $2@$2.10 per 100 lb. for carload lots and up to $2.50 for smaller quantities. On the other hand resale offerings of solid *caustic soda* appeared slightly freer and these had a tendency to depreciate spot prices because the demand did not assume active proportions. At intervals during the week caustic sold as low as $3.70 and as high as $3.90 per 100 lb. At the close resale material was quoted at $3.70@$3.80 per 100 lb. with contract prices unchanged at $3.60 per 100 lb. basis 60 per cent f.o.b. works. Foreign *muriate of potash* was offered at $67@$70 per ton basis 80 per cent f.o.b. N. Y. A good inquiry is reported for this important basic chemical and some business is going through. Buyers, however, are below these figures and it looks as though concessions would have to be granted to insure any active business.

Slightly lower prices were named by prominent dealers of *acetate of soda* and goods could be obtained at 5½c. per lb. f.o.b. works for prompt and future shipments. This price holds good only for round lots, smaller quantities being held as high as 6½c. per lb. Inquiry at present seems to be confined mostly to small lots for actual requirements. Moderate quantities of resale *bicarbonate of soda* are offered by dealers at $2.50 per 100 lb. in barrels, spot N. Y. Producers still quote the market at 2¾c. per lb. in barrels and 3c. in kegs f.o.b. works. Most holders of *bichromate of soda*, resale stock, are quoting the market at 8½c. per lb. Occasional sales of small lots went through at 8¼c., but there seems to be no apparent pressure of round lot offerings and it is doubtful if better than the outside figure could be done on carlots. Moderate offerings of outside makes were on the market at concessions, prices depending chiefly on the quantity desired. March shipments were generally quoted at 8¼c. per lb.

Amyl acetate, technical, was quoted lower by some prominent sellers, and it was stated that business could be placed at $3.25 per gal. Quotations were heard at $3.25@$3.50 per gal. depending upon the quantity. Scattered sales of imported *barium peroxide* have been reported of late and in one quarter the sale of a carlot at 17c. per lb. is recorded. The general quotation, however, ranges from 18@22c. per lb. Producers of *formaldehyde* remained steady at 18c. per lb. minimum for round lots and 20c. for smaller quantities. Moderate lots of resale stock are obtainable through second hands at 17½@17¾c. per lb. Some sales were reported at the inside figure. An easier feeling was noted in *prussiate of soda* on spot during the week and there were sellers from 16c. down to 15½c. per lb. Absence of important consuming inquiry has stimulated competition among dealers and prices have been reduced accordingly. Prompt shipments from abroad were obtainable at 15c. per lb. Scarcity in offerings of yellow *prussiate of potash* is keeping this chemical in a firm position and the best price heard was 28c. per lb. for small quantities only. Prompt shipments were quoted at 27c. per lb. The red variety also remained very scarce with sellers quoting 50@55c. per lb.

White *arsenic* on spot is to be had as low as 9c. per lb. in very fair volume. In some quarters prices are named up to 10½c. per lb., but no business has been reported above 10c. Producers' prices on *caustic potash* are lower, but in view of the demoralized state of the market this factor has had no noticeable effect. Resale lots of caustic of standard domestic brands are offered on the spot as low as 10@12c. per lb. with some dealers even in a position to shade the low figure on firm business. Imported caustic potash is offered at 11@13c. per lb. Producers are quoting 16@18c. per lb. admitting they are willing to shade these figures for real business. Producers of *copper sulphate* have reduced their quotations and in some directions stocks are to be had as low as 5½c. per lb. from manufacturers, although others are quoting up to 6c. per lb. The market for imported

material is very uncertain with a nominal quotation given as 5½c. per lb. No large stocks of imported sulphate could be located.

Manufacturers of *sulphuric acid* are holding prices fairly firm, although in the absence of actual business some shading has been done in certain quarters. Slowness throughout the chemical industry is reflected in the light demand for sulphuric. Producers, however, have held prices exceptionally firm considering all these conditions. Their attitude is that requirements will have to be taken care of whatever the price and they are not disposed to set a figure which will not yield them a fair profit. Prices remained quotably unchanged at former levels throughout the entire group.

Coal-Tar Products

Interest in the different branches of the coal tar products market reflected improvement. Buyers for both domestic consumption and export are entering the market with orders of larger volume for spot material, but there still lacks keen interest beyond present needs and little talk of contract business is heard. A few factors are trying hard to encourage future business since they believe that prices will be fairly steady for some time to come. Manufacturers of crude products have done business on an increasing scale and prices have held steady. Consumers of intermediates are showing more interest in supplies and sellers realizing that there is more honest intention of buyers to come into the market to buy and not merely shop around are showing more disposition to meet buyers' views, and lower prices are being quoted among manufacturers as well as second hands.

Prices on *benzene* remained unchanged in producers' hands although reports were heard to the effect that business has picked up perceptibly. Quotations are made on the basis of 30@35c. per gal. for pure benzene in drums and tank cars. The 90 per cent grade is held at 28@32c. per gal. on the same basis. The increased business in this material has seemed to confine itself mostly to the 90 per cent grade, although some increase has been noted in the amount of business done in pure benzene. The market on *naphthalene* seems to be taking on some activity and with supplies scarce in second hands prices are holding steady. Resale lots of the ball variety were heard toward the close at 9¼c. per lb., while flakes ranged from 8¼@8½c. per lb. Producers' figures on flakes are quoted around 9@10c. per lb. and balls from 10@12c. Continued small lot buying of *phenol* has placed the spot market in an increasingly stronger position. The only stocks which are available in the open market are quite firmly held with most sellers asking as high as 11c. per lb. There seem to be small lots around at 10c. per lb., although these are becoming much harder to locate. Government surplus phenol is still offered at 12c. per lb.

The past week has shown the *aniline oil* market rather weak with available material easy and sellers offering as low as 20½c. per lb. Consumers are showing little disposition to take hold of any but small lots. Trading in *aniline salt* showed a tendency to improve with sales in a little larger volume. While supplies seem to be fairly easy, prices are more firmly held at 28@30c. per lb. Business in *beta-naphthol* below 33½c. per lb. seems to be impossible, but some sales were recorded at or near this figure. Quotations range from 33½c. up to 45c. per lb. according to seller. The spot lots of distressed material which have held the market in its recent weak position seem to be moving into stronger hands and the market is correspondingly firmer. The lowest price quoted at present by producers is 40c. per lb.

Prices on *paranitraniline* quoted by producers continue well above the spot market. Second hands offer stocks as low as 85c. per lb. with producers quoting up to $1.05 per lb. There has been very little change in the quiet trading of *dimethylaniline*. Sellers are not pushing business very hard and it is not thought that much better than 55@60c. per lb. could be done. Sales of U. S. P. *salicylic acid* have been reported in the market at prices approaching the technical grade. Producers are quoting 22@23c. for the technical acid, but are doing little business at this figure. Quotations on *alpha-naphthylamine* have remained unchanged on a dull market. Prices are variously given at 38@40c. per lb. according to seller. Business has been of such limited proportion that producers have not felt the necessity of bringing prices into better alignment.

Waxes

The demand for refined *beeswax* is reported good, but trading in the raw material has fallen off so that prices in some directions are barely steady. For the lower grade of crude beeswax prices range from 17@19c. per lb., depending upon color, quantity and seller. Refined wax is held at 27@35c. per lb. With little change in prices at primary points the market on *carnauba wax* was an uninteresting affair. Demand was described as routine. Offerings of the higher grades on spot were limited, but the common varieties appeared plentiful. No. 2 North Country grade closed unchanged at 18@19c. per lb. with the flora grade held at 70@71c. per lb.

Spot quotations for *Japan wax* were steady under moderate offerings and leading factors continued to quote from 19@20c. per lb. With the crude oil situation easier and no improvement in the export call the market for *paraffine wax* was unsettled throughout the week. Round lots of scale wax were offered by producers on the basis of 3½c. per lb. f.o.b. refinery without attracting any buyers. Refined wax of 130 degree melting point closed nominally at 6¼c. per lb.

The Iron and Steel Market

Pittsburgh, Feb. 25, 1921.

Conditions in the steel industry are working out in harmony with the theory stated in this report a week ago, that the price cutting produces no more business for the independent producers, and reduces the operation of the Steel Corporation. The price cutting has proceeded somewhat farther, but not much farther, chiefly because there is so little incentive by way of important inquiry coming out.

It is very doubtful whether the bookings of the independent mills, since the price cutting began, have been as heavy as they would have been if there had been no price cutting.

As to Steel Corporation operations there has been a very marked effect. It must be understood, of course, that the corporation's operations were marked for a decline, since at the beginning of the year many customers of the corporation were taking steel at a rate well beyond their current consumption, but the corporation's operations have been decreasing by reason of the price cutting much more rapidly than would otherwise have been the case. In the fore part of January the corporation operated at an average of about 92 per cent, measured in steel ingot production against rated capacity. Last week the corporation operated at not over 75 per cent and this week it is averaging not over 65 per cent. A somewhat similar rate of recession is to be expected in the next few weeks.

It is now rather generally understood that the independents, in cutting prices, did not expect to book any considerable tonnage of business, but hoped to produce eventually a redistribution of business, and expected to induce the Steel Corporation to reduce wages, as the majority of independents had already done, the reductions beginning in the fore part of last December. Effective February 16 the independents in the Youngstown district reduced wages and salaries generally by about 20 per cent. Yesterday the Jones & Laughlin Steel Company announced a similar reduction, effective March 1. These latest reductions involve, in the case of common labor, a reduction from 46 to 37 cents an hour.

Steel Corporation Firm

The United States Steel Corporation displays no indication whatever of being moved by these developments, in price and wage reductions. The corporation refuses to be stampeded, and that is certainly not remarkable in view of the truly spectacular performance of the corporation last year in refraining from advancing its prices when all the independents advanced and when the corporation's costs were somewhat increased by what occurred at independent mills, as well as by the wage advance of February 1 and the freight rate advance of August 26.

There is no question, of course, that the corporation will eventually reduce both prices and wages. The question is merely as to the time. No one has basis for predicting that the corporation will not wait months, although it is possible that action will be taken within a very short time.

Independent Declines

Plainly defined declines in finished steel prices from the prices quoted a week ago are not particularly important. Plates can be done at $3 a ton less, black sheets at $1 a ton less and galvanized sheets at $2 a ton less. Prices now quoted as the minimum of the open market, however, are probably in all cases subject to further discount in the event of a buyer offering an order sufficiently attractive in point of tonnage and specifications. Indeed, an outstanding feature of the attitude of some mills in quoting prices is that they do not represent the prices quoted as being a set minimum, but merely as being their price on the particular inquiry involved. The mills are careful to say nothing that might be interpreted by a possible buyer as a suggestion not to come back with other inquiries. Prices openly quotable, compared with Industrial Board or Steel Corporation prices, are now as follows: Bars, 2c. against 2.35c.; shapes, 2.20c. against 2.45c.; plates, 2.10c. against 2.65c.; plain wire, 3c. against 3.25c.; wire nails, $3.10 against $3.25; hoops, 2.85c. against 3.05c.; blue annealed sheets, 3.20c. against 3.55c.; black sheets, 4.10c. against 4.35c.; galvanized sheets, 5.25c. against 5.70c.

Tin plate remains firm at $7 per base box, 100-lb. As for quite a while past there are offerings at second hand at deep cuts. Independent tin plate mills seem to be booking a trifle more business than formerly. The leading interest is in the third week of a four-week schedule of 70 per cent operation at its tin plate mills, and finds the operation involves the making of less stock than was expected, there being very fair shipments.

Standard steel pipe is not yet openly quotable at any decline, but some jobbers are selling at the mill price, and some other descriptions of welded steel tubular goods are going at concessions. Pipe mill operations are still heavy, even by the independents, pipe being quite different from all other finished steel commodities.

Semi-Finished Steel

Cut prices on sheet bars are now appearing freely. While the official price of the Steel Corporation is still $47, independent mills have willingly quoted $42 and it is reported one $40 quotation has been made, but $42 is merely the old Industrial Board price, the Steel Corporation having made a $5 advance last September. Some sheet mills speak as if they might take hold at $35, but in sheets as in some other lines the matter is still open whether the price of the raw material will make the price of the finished product, or the other way about. The market may be quoted nominal at $42 for sheet bars and $40 for billets.

Pig Iron and Coke

As a result of a very few sales basic pig iron is quotable down $2.50, to $25, valley, and foundry down $1, to $27, valley. Bessemer by inference from basic drops from $29, to $27, valley. These prices are well below cost of production based on cost of ore piles, purchased at last season's ore prices, and well below the recent cost of coke. The furnaces merely do not know how much their ore piles have depreciated in value, that depending on prices that will be developed for the 1921 ore season. As to coke, operators will sell at flat prices, below those that would be dictated by contracts now nominally in force, a typical contract being at 5 to 1 against basic pig iron, but with a $5.75 minimum, so that when basic iron declined below $28.75 the minimum would obtain instead of the ratio. One could buy at $5 and perhaps at less, certainly at much less if wages in the coke region were reduced. That seems to await action by the Steel Corporation on the general subject of wages, the independent operators in the Connellsville region being indisposed to act except under leadership of the Frick company.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	–	$0.55 – $0.60
Acetone	lb.	$0.13 – $0.13½	.13½ – .14
Acid, acetic, 28 per cent	100 lbs.	3.00 – 3.25	3.50 – 3.75
Acetic, 56 per cent	100 lbs.	6.00 – 6.25	6.50 – 6.75
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	10.50 – 11.00	11.25 – 11.50
Boric, crystals	lb.	.14½ – .15	.15½ – .16
Boric, powder	lb.	.15½ – .16½	.17 – .18
Citric	lb.	–	.45 – .47
Hydrochloric	100 lb.	1.45 – 1.60	1.75 – 2.00
Hydrofluoric, 52 per cent	lb.	.15 – .16	.16½ – .18
Lactic, 44 per cent tech	lb.	.10 – .11	.11½ – .12
Lactic, 22 per cent tech	lb.	.04½ – .05½	.06 – .07
Molybdic, C. P.	lb.	4.00 – 4.50	4.50 – 5.00
Muriatic, 20 deg. (see hydrochloric)		–	–
Nitric, 40 deg	lb.	.07 – .07½	.08 – .08½
Nitric, 42 deg	lb.	.08½ – .09	.09½ – .10
Oxalic, crystals	lb.	.15 – .15½	.16 – .17
Phosphoric, Ortho, 50 per cent solution	lb.	.15 – .15½	.16 – .16½
Picric	lb.	.30 – .32	.35 – .40
Pyrogallic, resublimed	lb.	–	2.30 – 2.40
Sulphuric, 60 deg., tank cars	ton	–	–
Sulphuric, 60 deg., drums	ton	–	14.00 – 15.00
Sulphuric, 66 deg., tank cars	ton	18.00 – 19.00	–
Sulphuric, 66 deg., drums	ton	21.00 – 22.00	22.50 – 23.00
Sulphuric, 66 deg., carboys	ton	–	–
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	23.00 – 24.00	–
Sulphuric, fuming, 20 per cent (oleum) drums	ton	25.00 – 26.00	26.50 – 27.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 – 35.00	40.00 –
Tannic, U. S. P.	lb.	–	1.15 – 1.25
Tannic (tech.)	lb.	.45 – .47	.48 – .50
Tartaric, crystals	lb.	–	.31 – .35
Tungstic, per lb. of WO	lb.	–	1.00 – 1.20
Alcohol, Ethyl	gal.	–	4.80 – 5.00
Alcohol, Methyl (see methanol)		–	–
Alcohol, denatured, 188 proof	gal.	–	.50 – .52
Alcohol, denatured, 190 proof	gal.	–	.54 – .56
Alum, ammonia lump	lb.	.04½ – .04¾	.05 – .05½
Alum, potash lump	lb.	.05½ – .06	.06¼ – .07
Alum, chrome lump	lb.	.13 – .13½	.14 – .14½
Aluminum sulphate, commercial	lb.	.02½ – .02¾	.02¾ – .03
Aluminum sulphate, iron free	lb.	.03 – .03½	.03½ – .03¾
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07 – .07½	.07¾ – .08
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .32	.33 – .35
Ammonium carbonate, powder	lb.	.11½ – .11¾	.12 – .12½
Ammonium chloride, granular (white salamoniac) (nominal)	lb.	.07½ – .08	.08¼ – .08½
Ammonium chloride, granular (gray salammoniac)	lb.	.09 – .09½	.09½ – .10
Ammonium nitrate	lb.	.08 – .08½	.09 – .10
Ammonium sulphate	100 lb.	3.25 – 3.35	3.40 – 3.60
Amylacetate	gal.	–	4.00 – 4.25
Amylacetate tech	gal.	–	3.25 – 3.50
Arsenic oxide, (white arsenic)	lb.	.09 – .09½	.10 – .10½
Arsenic, sulphide, powdered (red arsenic)	lb.	.14 – .14½	.15 – .15½
Barium chloride	ton	65.00 – 70.00	75.00 – 80.00
Barium dioxide (peroxide)	lb.	.18 – .19	.19½ – .22
Barium nitrate	lb.	.10 – .10½	.10½ – .11
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ – .05	.05½ – .06
Bleaching powder (see calc. hypochlorite)		–	–
Blue vitriol (see copper sulphate)		–	–
Borax (see sodium borate)		–	–
Brimstone (see sulphur, roll)		–	–
Bromine	lb.	.40 – .41	.42 – .45
Calcium acetate	100 lbs.	2.00 – 2.05	–
Calcium carbide	lb.	.04 – .04½	.04½ – .05
Calcium chloride, fused, lump	ton	27.00 – 29.00	30.00 – 32.00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – .02½
Calcium hypochlorite (bleach'g powder)	lb.	.02½ – .03	.03½ – .03¾
Calcium peroxide	lb.	–	1.00 – 1.10
Calcium phosphate, monobasic	lb.	–	.15 – .16
Camphor	lb.	–	.70 – .75
Carbon bisulphide	lb.	.08 – .08½	.09 – .09½
Carbon tetrachloride, drums	lb.	.11½ – .11¾	.12 – .12½
Carbonyl chloride (phosgene)	lb.	–	.75 – 1.00
Caustic potash (see potassium hydroxide)		–	–
Caustic soda (see sodium hydroxide)		–	–
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 – .09½	.10 – .10½
Chloroform	lb.	–	.38 – .40
Cobalt oxide	lb.	–	3.00 – 3.10
Copperas (see iron sulphate)		–	–
Copper carbonate, green precipitate	lb.	.24 – .25	.26 – .27
Copper cyanide	lb.	–	.50 – .60
Copper sulphate, crystals	lb.	.05½ – .05¾	.06 – .06½
Cream of tartar (see potassium bitartrate)		–	–
Epsom salt (see magnesium sulphate)		–	–
Ethyl Acetate Com. 85%	gal.	–	1.05 – 1.10
Ethyl Acetate pure (acetic ether 98% to 100%)		–	–
Formaldehyde, 40 per cent	lb.	.17¼ – .17½	.17½ – .18
Fusel oil, ref	gal.	–	4.00 – 4.50
Fusel oil, crude	gal.	–	2.50 – 2.75
Glauber's salt (see sodium sulphate)		–	–
Glycerine, C. P. drums extra	lb.	–	.20 – .21
Iodine, resublimed	lb.	–	3.75 – 3.85
Iron oxide, red	lb.	–	.10 – .20
Iron sulphate (copperas)	100 lb.	1.00 – 1.25	1.50 – 1.75
Lead acetate, normal	lb.	–	.14½ – .16
Lead arsenate (paste)	lb.	.11 – .12	.12½ – .13
Lead nitrate	lb.	–	.15 – .20
Litharge	lb.	.08¼ – .09	.09½ – .10
Lithium carbonate	lb.	–	1.25 –
Magnesium carbonate, technical	lb.	.10½ – .11	.11½ – .12
Magnesium sulphate, U. S. P.	100 lb.	2.00 – 2.50	–
Magnesium sulphate, commercial	100 lb.	–	1.50 – 1.75
Methanol, 95%	gal.	–	1.22 – 1.24
Methanol, pure	gal.	–	1.55 – 1.60
Nickel salt, double	lb.	–	.12 – .12½
Nickel salt, single	lb.	–	.13 – .13½
Phosgene (see carbonyl chloride)		–	–
Phosphorus, red	lb.	.45 – .46	.47 – .50
Phosphorus, yellow	lb.	–	.35 – .37
Potassium bichromate	lb.	.13 – .13½	.14 – .14½

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	$ .. – $	$0.30 – $0.35
Potassium bromide, granular	lb.	.... –	.20 – .40
Potassium carbonate, U. S. P.	lb.	.35 – .40	.45 – .50
Potassium carbonate, crude	lb.	.08 – .08½	.09 – .10
Potassium chlorate, crystals	lb.	.08 – .10	.11 – .18
Potassium cyanide	lb.	.... –	.45 – .50
Potassium hydroxide (caustic potash)	lb.	.10 – .11	.12 – .13
Potassium muriate	ton	67.00 – 70.00	.... – ....
Potassium iodide	lb.	.... –	2.75 – 3.00
Potassium nitrate	lb.	.09¼ – .09½	.10 – .12¼
Potassium permanganate	lb.	.45 – .46	.48 – .50
Potassium prussiate, red	lb.	.50 – .52	.53 – .55
Potassium prussiate, yellow	lb.	.28 – .29	.30 – .32
Potassium sulphate (powdered)	per uni	.... –	.... – 2.25
Rochelle salts (see sodium potas tartrate)		.... –	.... – ....
Salammoniac (see ammonium chloride)		.... –	.... – ....
Sal soda (see sodium carbonate)		.... –	.... – ....
Salt cake	ton	.... –	32.00 – 33.00
Silver cyanide	oz.	.... –	1.25 – ....
Silver nitrate	oz.	.... –	.40½ – .41½
Soda ash, light	100 lb.	2.00 – 2.10	2.20 – 2.50
Soda ash, dense	100 lb.	2.20 – 2.30	2.40 – 2.60
Sodium acetate	lb.	.05½ – .05½	.06 – .06½
Sodium bicarbonate	100 lb.	2.50 – 2.75	3.00 – 3.25
Sodium bichromate	lb.	.08½ – .08½	.09 – .09¼
Sodium bisulphate (nitre cake)	ton	7.00 – 7.50	8.00 – 11.00
Sodium bisulphite powdered, U.S.P.	lb.	.05½ – .05½	.06 – .06½
Sodium borate (borax)	lb.	.08¼ – .08½	.08¼ – .09
Sodium carbonate (sal sod)	100 lb.	2.00 – 2.25	2.50 – 2.75
Sodium chlorate	lb.	.10 – .10½	.10¼ – .11
Sodium cyanide, 96-98 per cent	lb.	.18 – .19	.20 – .28
Sodium fluoride	lb.	.13 – .14	.14½ – .15
Sodium hydroxide (caustic soda)	100 lb.	3.70 – 3.80	3.90 – 4.10
Sodium hyposulphite	lb.	.... –	.03¾ – .04
Sodium nitrate	100 lb.	2.85 –	3.00 – ....
Sodium nitrite	lb.	.06 – .06¼	.06½ – .07
Sodium peroxide, powdered	lb.	.30 – .31	.32 – .34
Sodium phosphate, dibasic	lb.	.04 – .04¼	.04½ – .05
Sodium potassium tartrate (Rochelle salts)	lb.	.... –	.29 – .31
Sodium prussiate, yellow	lb.	.15½ – .15½	.15½ – .16
Sodium silicate, solution (40 deg.)	lb.	1.10 – 1.15	1.20 – 1.40
Sodium silicate, solution (60 deg.)	lb.	.02½ – .03	.03½ – .03½
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	1.75 – 2.00	2.25 – 2.50
Sodium sulphide, crystal, 60-62 per cent (conc.)	lb.	.05 – .05½	.05½ – .06
Sodium sulphite, crystals	lb.	.04 – .04½	.04½ – .05
Strontium nitrate, powdered	lb.	.16 – .16½	.16½ – .17
Sulphur chloride, red	lb.	.07 – .07¼	.07½ – .08
Sulphur, crude	ton	16.00 – 20.00	.... – ....
Sulphur dioxide, liquid, cylinders	lb.	.08 – .08¼	.08½ – .09
Sulphur (sublimed) flour	100 lb.	.... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	.... –	2.00 – 2.75
Tin bichloride, 50 per cent	lb.	.18 – .19	.... – ....
Tin oxide	lb.	.... –	.45 – .47
Zinc carbonate, precipitate	lb.	.16 – .18	.19 – .20
Zinc chloride, gran.	lb.	.11 – .11½	.11½ – .12
Zinc cyanide	lb.	.45 – .49	.50 – .60
Zinc dust	lb.	.12 – .13	.13½ – .14
Zinc oxide, XX	lb.	.08½ – .09	.09½ – .11
Zinc sulphate	lb.	.03¼ – .03¾	.04 – .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.10 — $1.15
Alpha-naphthol, refined	lb.	1.45 — 1.50
Alpha-naphthylamine	lb.	.38 — .40
Aniline oil, drums extra	lb.	.20½ — .26
Aniline salts	lb.	.27 — .30
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.00 — 1.50
Benzidine, base	lb.	.95 — 1.05
Benzidine sulphate	lb.	.80 — .90
Benzoic acid, U.S.P.	lb.	.70 — .75
Benzoate of soda, U.S.P.	lb.	.70 — .80
Benzene, pure, water-white, in drums (100 gal.)	gal.	.30 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.28 — .32
Benzyl chloride, 95-97%, refined	lb.	.30 — .35
Benzyl chloride, tech.	lb.	.25 — .30
Beta-naphthol benzoate	lb.	3.50 — 4.00
Beta-naphthol, sublimed	lb.	.70 — .75
Beta-naphthol, tech.	lb.	.33½ — .40
Beta-naphthylamine, sublimed	lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .18
Ortho-cresol, in drums (100 lb.)	lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums	gal.	.95 — 1.00
Cresylic acid, 75-97%, dark, in drums	gal.	.90 — .95
Cresylic acid, 50%, first quality, drums	gal.	.60 — .65
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.20 — 1.30
Dimethylaniline	lb.	.55 — .65
Dinitrobenzene	lb.	.30 — .32
Dinitroclorbenzene	lb.	.25 — .30
Dinitronaphthalene	lb.	.33 — .35
Dinitrophenol	lb.	.40 — .45
Dinitrotoluene	lb.	.25 — .30
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 — .40
Diphenylamine	lb.	.60 — .70
H-acid	lb.	1.30 — 1.50
Meta-phenylenediamine	lb.	1.25 — 1.30
Monochlorbenzene	lb.	.14 — .16
Monoethylaniline	lb.	1.75 — 2.00
Naphthalene crushed, in bbls. (250 lb.)	lb.	.08 — .08½
Naphthalene, flake	lb.	.08¼ — .08½
Naphthalene, balls	lb.	.09¼ — .10
Naphthionic acid, crude	lb.	.70 — .75
Nitrobenzene	lb.	.12 — .15
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.18 — .25
Ortho-amidophenol	lb.	3.20 — 3.75
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.20 — .24
Ortho-toluidine	lb.	.25 — .30
Para-amidophenol, base	lb.	1.90 — 2.00
Para-amidophenol, HCl	lb.	2.10 — 2.20
Para-dichlorbenzene	lb.	.15 — .25
Paranitroaniline	lb.	.85 — 1.00
Para-nitrotoluene	lb.	.90 — 1.05
Para-phenylenediamine	lb.	1.90 — 2.00
Para-toluidine	lb.	1.30 — 1.60
Phthalic anhydride	lb.	.55 — .60
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.10 — .12
Pyridine	gal.	2.00 — 3.50
Resorcinol, technical	lb.	1.85 — 2.00
Resorcinol, pure	lb.	2.30 — 2.50
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.22 — .23
Salicylic acid, U. S. P.	lb.	.25 — .27
Salol	lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.28 — .32
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.15 — .18
Sulphanilic acid, crude	lb.	.30 — .35
Tolidine	lb.	1.35 — 1.45
Toluidine, mixed	lb.	.40 — .45
Toluene, in tank cars	gal.	.28 — .32
Toluene, in drums	gal.	.30 — .35
Xylidines, drums, 100 gal.	lb.	.40 — .45
Xylene, pure, in drums	gal.	.42 — .45
Xylene, pure, in tank cars	gal.	.45 — ....
Xylene, commercial, in drums, 100 gal.	gal.	.33 — .35
Xylene, commercial, in tank cars	gal.	.30 — ....

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.24 — $0.26
Beeswax, refined, light	lb.	.27 — .28
Beeswax, white pure	lb.	.40 — .45
Carnauba, Fl ra	lb.	.70 — .71
Carnauba, No. 2, North Country	lb.	.30 — .32
Carnauba, No. 3, North Country	lb.	.18 — .19
Japan	lb.	.19 — .20
Montan, crude	lb.	.07 — .08
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04½ — .04½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.03½ — .03¾
Paraffine waxes, refined, 118-120 m.p.	lb.	.04½ — .05
Paraffine waxes, refined, 125 m.p.	lb.	.05½ — ....
Paraffine waxes, refined, 128-130 m.p.	lb.	.06¼ — ....
Paraffine waxes, refined, 133-135 m.p.	lb.	.07¼ — .07½
Paraffine waxes, refined, 135-137 m.p.	lb.	.08¼ — .09
Stearic acid, single pressed	lb.	.12 — ....
Stearic acid, double pressed	lb.	.12½ — ....
Stearic acid, triple pressed	lb.	.13½ — ....

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr., 0.930-0.940	gal.	$1.70
Pine oil, pure, dest. dist.	gal.	1.60
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.20
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.	.37
Pinewood creosote, ref	gal.	.55

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B- , bbl	280 lb.	$6.75	— ....
Rosin E-I	280 lb.	6.75	— ....
Rosin K-N	280 lb.	6.75	— ....
Rosin W. G.-W. W.	280 lb.	7.00	— ....
Wood rosin, bbl	280 lb.	7.25	— ....
Spirits of turpentine	gal.	.56	— ....
Wood turpentine, steam dist	gal.	.54	— ....
Wood turpentine, dest. dist	gal.	.53	— ....
Pine tar pitch, bbl	200 lb.	....	— 8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	....	— 15.00
Retort tar, bbl	500 lb.	15.00	— 15.50
Rosin oil, first run	gal.	.50	— ....
Rosin oil, second run	gal.	.52	— ....
Rosin oil, third run	gal.	.60	— ....

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.41
70-72 deg., steel bbls. (85 lb.)	gal.	.39
68-70 deg., steel bbls. (85 lb.)	gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.30

Crude Rubber

Para—Upriver fine	lb.	$0.17	— $0.18
Upriver coarse	lb.	.13	— .14
Upriver caucho ball	lb.	.14	— .14¼
Plantation—First latex crepe	lb.	.19½	— ....
Ribbed smoked sheets	lb.	.18¼	— ....
Brown crepe, thin, clean	lb.	.18	— ....
Amber crepe No. 1	lb.	.20	— ....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.09	— $0.09½
Castor oil, AA, in bbls	lb.	.10	— .10½
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.08	— .08½
Cocoanut oil, Ceylon grade, in bbls	lb.	.11½	— .11½
Cocoanut oil, Cochin grade, in bbls	lb.	.11½	— .12
Cor oil, crude, in bbls	lb.	.08½	— .09
Cottonseed oil, crude (f. o. b. mill)	lb.	.05¾	— .05½
Cottonseed oil, summer yellow	lb.	.07	— .07¼
Cottonseed oil, wi ter yellow	lb.	.08	— .08¼
Linseed oil, raw, car lots (domestic)	gal.	.67	— .68
Linseed oil, raw, tank cars (domestic)	gal.	.60	— ....
Linseed oil, boiled, car lots (domestic)	gal.	.69	— .70

Olive oil, commercial	gal.	$2.60 —	$2.75
Palm, Lagos	lb.	.07½ —	.07¾
Palm, Niger	lb.	.06½ —	.06¾
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.06½ —	.06¾
Peanut oil, refined, in bbls	lb.	.12½ —	.13
Rapeseed oil, refined in bbls	gal.	1.05 —	1.10
Rapeseed oil, blown, in bbls	gal.	1.15 —	1.20
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.07½ —	.07¾
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.04½ —	....
FISH			
Light pressed menhaden	gal.	$0.46 —	$0.48
Yellow bleached menhaden	gal.	.48 —	.50
White bleached menhaden	gal.	.50 —	.52
Blown menhaden	gal.	.85 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00 —	30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00 —	26.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	10.00 —	12.00
Barytes, floated, f.o.b. St. Louis	net ton	26.50 —	28.00
Barytes, crude, first grade, Missouri	net ton	10.00 —	....
Blanc fixe, dry	lb.	.05 —	.05½
Blanc fixe, pulp	net ton	50.00 —	60.00
Casein	lb.	.14 —	.16
Chalk, domestic, extra light	lb.	.05 —	.05½
Chalk, domestic, light	lb.	.04½ —	.05
Chalk, domestic, heavy	lb.	.04 —	.05
Chalk, English, extra light	lb.	.05 —	.07
Chalk, English, light	lb.	.05 —	.06
Chalk, English, dense	lb.	.04½ —	.05
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	8.00 —	10.00
China clay (kaolin) washed, f.o.b. Georgia	net ton	12.00 —	15.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	18.00 —	22.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	15.00 —	40.00
China clay (kaolin), imported, lump	net ton	23.00 —	25.00
China clay (kaolin), imported, powdered	net ton	30.00 —	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	8.00 —	14.00
Feldspar, crude, f.o.b. Maine	net ton	7.50 —	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00 —	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00 —	30.00
Fullers earth, f.o.b. Mines	net ton	16.00 —	17.00
Fullers earth, granular, f.o.b. Fla	net ton	25.00 —	....
Fullers earth, powdered, f.o.b. Fla	net ton	18.00 —	....
Fullers earth, imported, powdered	net ton	35.00 —	40.00
Graphite, crucible, 90% carbon, Ashland, Ala	lb.	.... —	.09
Graphite, crucible, 85% carbon, Ashland, Ala	lb.	.07 —	.09
Graphite, higher lubricating grades	lb.	.11 —	.40
Pumice stone, imported, lump	lb.	.04 —	.50
Pumice stone, domestic lump	lb.	.05 —	.05½
Pumice stone, ground	lb.	.06 —	.07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	.... —	10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	.... —	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	.... —	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 —	7.50
Shellac, orange fine	lb.	.65 —	....
Shellac, orange superfine	lb.	.70 —	....
Shellac, A. C. garnet	lb.	.57 —	....
Shellac, T. N.	lb.	.55 —	....
Soapstone	ton	12.00 —	15.00
Sodium chloride	long ton	14.00 —	15.00
Talc, paper-making grades, f.o.b. Vermont	ton	12.00 —	22.00
Talc, roofing grades, f.o.b. Vermont	ton	9.50 —	15.00
Talc, rubber grades, f.o.b. Vermont	ton	12.00 —	18.00
Talc, powdered, Southern, f.o.b. cars	ton	12.00 —	15.00
Talc, imported	ton	40.00 —	50.00
Talc, California talcum powder grade	ton	20.00 —	45.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	1,000	160
Chrome brick, f.o.b. Eastern shipping points	net ton	80–100
Chrome cement, 40–45% Cr_2O_3	net ton	45– 50
Chrome cement, 40–45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	....– 55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	55– 60
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	45– 50
Magnesite brick, 9-in. straight	net ton	100
Magnesite brick, 9-in. arches, wedges and keys	net ton	105
Magnesite brick, soaps and splits	net ton	120
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	65– 70
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	56– 61
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa	1,000	50– 60

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$225.00
Ferrochrome per lb. of Cr. contained, 6–8% carbon, carlots	lb.	.16 —	...
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.16 —	.17
Ferromanganese, 76-80% Mn, domestic	gross ton	95.00 —	100.00
Ferromanganese, 76-80% Mn, English	gross ton	95.00 —	100.00
Spiegeleisen, 18-22% Mn	gross ton	38.00 —	40.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.00 —	2.50
Ferrosilicon, 10-15%	gross ton	50.00 —	55.00
Ferrosilicon, 50%	gross ton	80.00 —	85.00
Ferrosilicon, 75%	gross ton	150.00 —	155.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.55 —	.60
Ferrouranium, 35-50% of U, per lb. of U content	lb.	7.00 —	....
Ferrovanadium, 30-40% per lb. of contained V	lb.	5.00 —	5.25

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content, less than 2% Fe_2O_3, up to 20% silica, not more than H 4% moisture	gross ton	$10.00 —	$11.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.55 —	.60
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	unit	.50 —	.55
Coke, foundry, f.o.b. ovens	net ton	6.00 —	6.50
Coke, furnace, f.o.b. ovens	net ton	5.00 —	5.50
Coke, petroleum, refinery, Atlantic seaboard	net ton	16.00 —	17.00
Fluorspar, lump, f.o.b. Heathden, New Mexico	net ton	17.50 —	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	22.50 —	25.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01¼ —	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.40 —	.45
Manganese ore, chemical (MnO_2)	gross ton	60.00 —	65.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.55 —	.60
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	30.00 —	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.16 —	....
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.16½ —	....
Pyrites, domestic, fines, f.o.b. mines, Ga	unit	.12 —	.14
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —	....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	3.00 —	3.25
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	3.00 —	3.25
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.50 —	2.50
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.50 —	....
Zircon, washed, iron free	lb.	.03 —	....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.50
Aluminum, 98 to 99 per cent	28.3@28.5
Antimony, wholesale lots, Chinese and Japanese	5.25
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Monel metal, spot and blocks	35
Monel metal, ingots	38
Monel metal, sheet bars	40
Tin, 5-ton lots	32.00
Lead, New York, spot	4.00
Lead, E. St. Louis, spot	4.00
Zinc, spot, New York	7.00
Zinc, spot, E. St. Louis	4.80@4.90

OTHER METALS

Silver (commercial)	oz.	$0.56
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.35@2.40
Cobalt	lb.	4.50
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	70.00
Iridium	oz.	325.00
Palladium	oz.	65.00@70.00
Mercury	75 lb.	46.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	21.25
Copper bottoms	33.00
Copper rods	28.00
High brass wire and sheets	18.75
High brass rods	16.75
Low brass wire and sheets	27.50
Low brass rods	18.50
Brazed brass tubing	35.25
Brazed bronze tubing	40.50
Seamless copper tubing	25.00
Seamless high brass tubing	24.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	11.50	18.50	10.00	10.50
Copper, heavy and wire	11.00	16.50	9.50	9.50
Copper, light and bottoms	9.00	14.50	9.00	8.50
Lead, heavy	4.00	7.25	4.00	4.00
Lead, tea	3.00	5.25	3.00	3.00
Brass, heavy	7.00	9.50	7.00	10.00
Brass, light	5.50	8.00	5.00	5.50
No. 1 yellow brass turnings	6.00	9.50	5.50	6.00
Zinc	4.00	5.00	3.00	3.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	*Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$3.73	$3.80	$3.47	$3.58	$3.37	$3.58	$3.47
Soft steel bars	3.93	3.70	3.52	3.34	3.27	3.48	3.52
Soft steel bar shapes	3.93	3.70	3.52	3.48	3.27	3.48	3.52
Soft steel bands	4.33	4.65	4.22	6.25	....	....	....
Plates, ¼ to 1 in. thick	3.93	4.00	3.67	3.78	3.57	3.78	3.67

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

HUNTSVILLE—The F. & O. Cedar Works, specializing in the manufacture of cedar and other oils, is planning for the rebuilding of its plant, recently destroyed by fire. Lucien Hewlett is manager.

Arkansas

BATESVILLE—The Planters' Lime, Phosphate & Fertilizer Co., recently organized with a capital of $1,500,000, is planning for the erection of a new plant for the production of hydrated lime and other lime products, with department of the works devoted to the manufacture of fertilizer. The company has a large tract of property in this section. J. R. Alexander, Scotts, Ark., is president; J. W. Williamson, Batesville, is secretary.

California

SAN FRANCISCO—The General Petroleum Co., 310 Sansome Street, has arranged for a note issue of $7,500,000, the proceeds to be used, in part, for proposed extensions in refineries, improvements, and general expansion.

BURBANK—The Empire China Co. has commenced the erection of a new plant, consisting of three one-story, brick factories, 140 x 318 ft., 32 x 318 ft., and 24 x 125 ft., respectively. The works will be used for the manufacture of chinaware, porcelain, etc., and is estimated to cost about $80,000. Farley & Farley, Burbank, have the construction contract.

LOS ANGELES—The Pacific Clay Products Co., American Bank Building, has preliminary plans under way for the construction of an addition to its plant at Los Nietos, near Whittier, to be used for the manufacture of brick and other burned clay products. The first unit will have a capacity of 25,000 bricks per day to be supplemented later with a second unit of about 15,000 daily output.

Delaware

WILMINGTON—The Martin Leather Co. has acquired the former leather works of Barr & Dougherty, 707 East Fifth St., more recently owned by the Standard Kid Mfg. Co., for a consideration said to be about $90,000. The new owner will improve the works, with the installation of new equipment as required. Production will be inaugurated on a small scale and increased as soon as conditions warrant.

Florida

MIAMI—The Standard Poured Brick Co. is planning for the erection of a large addition to its plant in the Miami Canal district, increasing the present output of about 5,000 bricks per day to 50,000 bricks daily.

WEST PALM BEACH—W. J. Carroll, P. O. Box 611, and associates, have plans under way for the construction of a new glass manufacturing plant. A site has been selected and machinery will be purchased at an early date.

Georgia

SAVANNAH—The Southern Fertilizer & Chemical Co. will inaugurate operations at once at its new local plant, recently completed. The new factory represents an investment of close to $1,000,000 and will replace the company's works at Huchinson Island, destroyed by fire in 1920. The new plant will specialize in the manufacture of finished fertilizer, with large department devoted to the production of acid phosphate. The production of the company's works at St. Mary's, Ga., and Philadelphia, Pa., will be utilized at the new factory.

METTER—The Metter Naval Stores Co. has preliminary plans under way for the construction of a new turpentine manufacturing plant in the vicinity of Register, Ga., to cost about $23,000.

Maryland

BALTIMORE—The Zirconium Co. of America, recently organized under state laws to manufacture ferrozirconium, zirconium oxide, and other refractory products, has acquired the property of the Baltimore Rubber Tire Mfg. Co., Monument and Eleventh Streets, consisting of about 2½ acres of land and 6 factory buildings. The present structures will be remodeled and improved, and equipped for the manufacture of the new line. It is proposed to commence operations at an early date. The company is headed by George F. Dixon, president; Philip C. Spencer, vice-president; Morris Meyer, treasurer; and Charles W. Smiley, 1622 Smallwood Street, secretary.

Massachusetts

EAST BRIDGEWATER—The Old Colony Foundry Co., Cook Street, will break ground early in March for the erection of an addition to its plant. Plans are now being prepared. Improvements will also be made in the present building. Charles L. Nutter is treasurer.

SPRINGFIELD—The United States Envelope Co., manufacturer of paper specialties, is arranging for the early occupancy of its new four-story plant addition now nearing completion. The factory with machinery is estimated to cost about $400,000.

Minnesota

MINNEAPOLIS—The plant of the Minneapolis Paper Supply was destroyed by fire, Feb. 20, with loss estimated at about $150,000, including equipment. The company is reported to be planning for the rebuilding of the works.

MINNEAPOLIS—The Twin City Separator Co., 2830 Colfax Avenue, manufacturer of separating equipment for mechanical service, has plans under way for the erection of a one-story addition to be located at Seventeenth and Madison Sts. C. O. Paulson is secretary and treasurer.

Michigan

SAGINAW—The Standard Oil Co., 910 South Michigan Avenue, Chicago, Ill., has preliminary plans under way for the erection of a new 2-story and basement building at Saginaw, 75 x 150 ft., to cost about $100,000.

New Jersey

NEWARK—The Ocean Leather Co., Inc., 33 New York Ave., has plans under way for the erection of a new plant in the vicinity of Beaufort, S. C., for converting the skins of sharks and other sea monsters into leather. A large reduction works will be established in connection with the plant.

North Carolina

GLENDON—The Talc Products Co., 7-9 Hanover Street, New York, N. Y., has plans under way for the construction of a new plant at Glendon. The company has a tract of about 200 acres of talc deposits, and the new plant will have an initial output of about 100 tons per day. A grinding plant will be installed. Charles A. Breiting is manager.

Ohio

BALTIMORE—The Fairfield Paper Box Co. has awarded a contract to the H. K. Ferguson Co., 6523 Euclid Ave., Cleveland, Ohio, for the erection of a new 2-story factory, with power house, at Delaware, Ohio, to cost about $160,000 with machinery. The works will consist of a paper mill and paper box factory. T. D. Griley is manager.

DAYTON—The Refinera Oil Co., 315 South Main St., is having plans prepared for the erection of a new 1- and 2-story building on South Ludlow St. R. S. King is president.

WILLARD—The Pioneer Rubber Co. is having plans prepared for the erection of an addition to its plant to cost about $50,000, to be 2-story, 60 x 160 ft. A number of homes for employees at the plant will also be constructed at an approximately like cost. B. O. Smith is president.

Oklahoma

YALE—The Buffalo Refining Co., recently organized, is planning for the erection of a new oil refinery with initial capacity of about 1,500 bbl. per day. G. W. Lillie is president, and Edward M. Weist, secretary and general manager.

Oregon

EUGENE—The Studebaker Rubber Co., Spokane, Wash., is negotiating for a local site for the erection of a new plant for the manufacture of automobile tires and other rubber products.

Pennsylvania

PHILADELPHIA—Fire, Feb. 17, at the plant of the Atlantic Refining Co., Thirty-fifth St. and River Road, caused a loss of about 100,000 gal. of oil and considerable equipment, including coke stills, etc. No official estimate of amount of loss has been made.

PHILADELPHIA — The Pennsylvania Wire Glass Co., Pennsylvania Bldg., is completing plans for the erection of its proposed new plant at Lewistown, Pa., to consist of a number of buildings of different sizes. It is expected to call for estimates at an early date.

South Carolina

CARLISLE—The Carlisle Cotton Oil Co. is planning for the rebuilding of its local plant, recently destroyed by fire.

Texas

EL PASO—The International Fiber Co., 610 Caples Bldg., recently organized with a capital of $500,000, has acquired a local building for its initial works, to be used for the manufacture of fiber specialties from certain kind of cacti. Equipment will be installed at once, including machine shop apparatus. At a later date the company proposes to build a new plant in this section. W. J. Rand is president.

GALVESTON—The Ribbon Works, Inc., recently organized to manufacture ribbons for writing and adding machines, etc., will establish a chemical and dye works in connection with its proposed new plant. Carbon-coating machinery for the manufacture of carbon papers, and other kindred equipment will be installed. J. D. Claitor is president and manager.

UVALDE—W. A. White, P. O. Box 247, and associates, have plans under way for the establishment of a new local plant for the manufacture soap products. A list of equipment to be installed will be arranged at an early date.

Virginia

LYNCHBURG—The Lynchburg Glass Works is planning for extensions and improvements in its plant for increased production. New machinery will be installed.

RICHMOND—The Phospho-Germ Mfg. Co., manufacturer of fertilizer, has completed plans for the erection of a new plant 65 x 76 ft., to be equipped for general manufacture. The plant will replace a factory recently destroyed by fire.

West Virginia

ROUND BOTTOM—H. J. Booth, Pittsburgh, Pa., is organizing a company to build a new plant here for the manufacture of glass products. Preliminary details of the factory are being arranged.

Washington

VANCOUVER—The Johnson Metal Refining Co. has filed plans for extensions and improvements in its plant. A new tinning works will be established.

ANACORTES—Plans are under way for the resumption of operations at the Anacortes Glass Co. plant. The works have been shut down for some time and a committee is obtaining funds through local subscriptions for remodeling and improving the factory, including the installation of new equipment.

SEATTLE—The General Basic Products Co., Harbor Island, is having plans prepared for the erection of a new four-story plant to be located on the East Marginal Way. Bids for construction and equipment will be asked at an early date. Henry Bittman, Securities Building, is architect and engineer.

Capital Increases, Etc.

THE COLONIAL CHEMICAL CORP., Reading, Pa., has filed notice of increase in its capital from $50,000 to $250,000 for financing and expansion.

THE LILLY VARNISH CO., Indianapolis, Ind., has filed notice of increase in its capital from $100,000 to $250,000 for general expansion.

THE ROCO CHEMICAL CO., Lawrenceburg, Ind., has filed notice of change of name to the Rossville Chemical Co.

THE WESTERN GLASS CO., Streator, Ill., manufacturer of glass products, has filed notice of increase in capital from $250,000 to $1,000,000.

THE PIEDMONT, MOUNT AIRY GUANO CO., Keyser Bldg., Baltimore, Md., manufacturer of fertilizer products, has increased its capital to $1,000,000. E. W. Levering is president.

THE CONNECTICUT OIL CO., Waterbury, Conn., has increased its outstanding capital to an amount of $95,150.

THE NEW MARTINSVILLE GLASS & MFG. CO., New Martinsville, W. Va., has increased its capital from $100,000 to $150,000. Ira Clarke is manager.

THE STANDARD METALS REFINING CO., South Bend, Ind., has filed notice of increase in capital from $50,000 to $75,000.

THE SARGENT PAINT CO., Indianapolis, Ind., has filed notice of increase in capital from $75,000 to $200,000.

THE PORTLAND CEMENT PRODUCT CO., La Salle, Ill., has filed notice of dissolution under state laws.

THE CHICAGO WRAPPER BOX & LABEL CO., Chicago, Ill., has filed notice of change of name to the Chicago-Elgin Carton Co., at the same time increasing its capital from $10,000 to $30,000.

New Companies

THE INDEPENDENT OIL & SUPPLY CO., 140 West Van Buren St., Chicago, Ill., has been incorporated with a capital of $15,000 to manufacture vegetable oils, etc. The incorporators are M. L. Coleman, Edward R. Drake, George N. Vail.

THE CO-OPERATIVE PHOSPHATE CO., Mulberry, Fla., has been incorporated with a capital of $500,000 to operate phosphate properties, manufacture fertilizers, etc. The incorporators are L. N. Pipkin, H. W. Wear and A. D. West, Mulberry.

THE O-C-T SECTIONAL TIRE & RUBBER CO., Kansas City, Mo., has been incorporated under Delaware laws with a capital of $1,000,000 to manufacture automobile tires and other rubber products. The incorporators are James B. O'Connor, Lawson Tarwater and S. L. Carter, all of Kansas City.

THE PROGRESSIVE VARNISH WORKS, 2458 E. 24th St., Los Angeles, Cal., has filed notice of organization to manufacture paints, varnish, oils, etc. The company is headed by Osmond Olsen and Albert Sailand.

A. F. LUCATI & CO., INC., New York, has been incorporated with a capital of $15,000 to manufacture chemicals and byproducts. The incorporators are C. Vignone, A. Baratta and A. Lucati, 23 W. 8th St.

THE HANSA CO., INC., Hoboken, N. J., has been incorporated with a capital of $30,000 to manufacture chemical products. The incorporators are M. Dillon, Thomas M. and William S. Stuhr, Hoboken.

THE KALBFLEISCH CORP., 31 Union Sq., New York, has been incorporated under Delaware laws with capital of $7,500,000 to manufacture chemicals and byproducts.

THE PAUL J. KREZ CO., 444 North La Salle St., Chicago, Ill., has been incorporated with a capital of 250 shares of stock, no par value, to manufacture asbestos, Magnesia and kindred products. The incorporators are Paul J. and John J. Krez, and Michael Koch.

THE SODIPHENE CO., 928 Central Ave., Kansas City, Mo., has been incorporated with a capital of $200,000 to manufacture chemical products. The incorporators are R. M. Seibel, B. A. Parsons and H. C. Campbell.

THE CONTINENTAL PAPER GRADING CO., 1451 South Peoria Street, Chicago, Ill., has been incorporated with a capital of $50,000 to manufacture paper products. The incorporators are Edward L. Kennedy, Arnold Epstein and Isaac Sandorff.

THE HOME LEATHER CO., INC., Detroit, Mich., has been incorporated with a capital of $50,000 to manufacture leather goods, findings, etc. The incorporators are Anton Martin, Olin A. Bullock and Vincent Elias, 337 East Farnum Street, Royal Oak, Detroit.

THE ENTLER & MUDGE CO., Feller's Hall Building, Martinsburg, W. Va., has been incorporated with a capital of $35,000 to manufacture paints, varnishes, etc. The incorporators are E. E. Entler, George E. Mudge and A. H. Stanley.

THE EAGLE PAINT & VARNISH WORKS, Brooklyn, N. Y., has been incorporated with a capital of $50,000 to manufacture paints, varnishes, oils, etc. The incorporators are M. R. Hillman, M. A. Plunkett and W. S. Rising, 1082 East Thirty-seventh Street, Brooklyn.

THE KIMMEL GLASS CO., Paterson, N. J., has been incorporated with a capital of $100,000 to manufacture glass products. The incorporators are Paul Wolff, S. and Hyman Kimmel, 14 West Street.

THE CLARK RUBBER CO., Franklin, Mass., has been incorporated with a capital of $100,000 to manufacture rubber products. The incorporators are Maurice C. Clark, Herbert L. Metcalfe and Leon B. Conant, Franklin.

THE BUILDERS' PAINT CO., Okmulgee, Okla., has been incorporated with a capital of $10,000 to manufacture paints, varnishes, etc. The incorporators are Carl Barnhart and O. J. Trussell, Okmulgee; and M. A. Oxley, Kansas City, Mo.

THE SPECIAL PRODUCTS CO., Boston, Mass., has been incorporated with a capital of $100,000 to manufacture chemicals and affiliated products. The incorporators are James R. Emmett, Justin Edwards and Arthur L. Norton, 113 High Street.

THE MERIT GLASS CO., New York, has been incorporated with a capital of $10,000 to manufacture glass specialties. The incorporators are A. L. Gaston, S. Kirschner and J. J. Friedman, 925 St. Nicholas Avenue.

THE RADIO X. SUPPLY CO., Detroit, Mich., has been incorporated with a capital of $50,000 to manufacture radio and chemical compounds and preparations. The incorporators are H. F. Carpenter, R. C. Burns and J. C. Hoover, 205 Woodward Avenue.

THE MARYLAND LIME MARL CO., Hagerstown, Md., has been incorporated with a capital of $75,000 to manufacture lime and affiliated products. The incorporators are Henry E. Bester, Frank D. Adams and Thomas L. Smith, Hagerstown.

THE M. C. CORNEZ LEATHER CO., INC., Boston, Mass., has been incorporated with a capital of $25,000 to manufacture leather products. The incorporators are R. C. Cornez, Archie E. Balter, and M. C. Cornez, 16 Parkman Street, Brookline, Mass.

THE REFINERS' PETROLEUM CO., 220 South State Street, Chicago, Ill., has been incorporated with a capital of $25,000 to manufacture refined petroleum products. The incorporators are H. A., G. S., and O. H. McCornack.

THE TRAXOL CO., 415 North Cicero Avenue, Chicago, Ill., has been incorporated with a capital of $6,000 to manufacture chemicals and drugs. The incorporators are D. and Charles A. Treckman, and Harry Goldberg.

THE ATLAS RUBBER CO., 912 Third Avenue, Huntington, W. Va., has been incorporated with a capital of $5,000 to manufacture rubber products. The incorporators are E. F. Hartley, C. L. Hibner and E. A. Jordan.

THE WELLSBORO SHALE BRICK CO., Wellsboro, Pa., has been incorporated with a capital of $20,000 to manufacture brick, tile and kindred products. The incorporators are Emil E. Rose, Toledo, Ohio, and associates.

THE MAXINE CO., Connersville, Ind., has been incorporated with a capital of $50,000 to manufacture chemicals and affiliated products. The incorporators are M. R. C. McKennan, and M. B. Murray.

ALEXANDER FRASER, INC., Oldtown, Me., has been incorporated with a capital of $50,000 to manufacture chemicals, drugs and affiliated products. The incorporators are Alexander Fraser and N. O'Connell, Oldtown.

THE BECKER-TABB PAINT CO., Louisville, Ky., has been incorporated with a capital of $20,000 to manufacture paints, varnishes, etc. The incorporators are C. H. Becker, J. Preston Tabb and John Manly.

THE LOCKPORT DEOXIDIZED BRONZE & METAL CO., Lockport, N. Y., has been incorporated with a capital of $30,000 to manufacture bronze and brass products, metal alloys, etc. The incorporators are P. K. Haber, J. Zaluski and J. C. Rock, Lockport.

THE W. D. YOUNG CO., Boston, Mass., has been incorporated with a capital of $75,000 to manufacture chemicals, drugs, and kindred products. The incorporators are Harry D. Evans, Guy A. Ham, and Harold P. Newell, 947 Boylston Street, Newton, Mass.

THE SOUTHERN CEDAR OIL CO., 1759 West Forty-eighth Street, Chicago, Ill., has been incorporated with a capital of $40,000 to manufacture oil products. The incorporators are Walter J. Warczak and Frank A. Kolesiak.

THE WALLACE PETROLEUM CO., Huntington, W. Va., has been incorporated with a capital of $50,000 to manufacture petroleum products. The company will operate in the vicinity of Louisa, Ky. The incorporators are M. E. Griffin, G. R. Jackson, Huntington; and F. D. T. Wallace, Jr., Louisa.

THE GRANADA SYRUP & SUGAR CO., Plaquemine, La., has been incorporated with a capital of $125,000 to operate a sugar mill. The incorporators are Oscar Richard, Sr., Sunshine, La.; and Edmund Becnell, Plaquemine.

S. L. CALECHMAN & SON, INC., New York, has been incorporated with a capital of $25,000 to manufacture chemicals and chemical compounds. The incorporators are S. L. Calechman, G. C. Sicklick and S. Glick, 20 West Ninety-sixth Street.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY, CHICAGO SECTION, plans to hold a joint meeting with the Illinois Clay Manufacturers Association of Chicago about March 8.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Products Analysts) will hold its twelfth annual meeting in Chicago May 16 to 17.

AMERICAN PAPER & PULP ASSOCIATION will hold its annual meeting at the Waldorf-Astoria and Hotel Astor, New York City, April 11 to 15.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

CANADIAN INSTITUTE OF MINING AND METALLURGY is holding its annual general meeting in the Chateau Laurier, Ottawa, Ont., March 2, 3 and 4.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its ninth annual meeting in Atlantic City April 27, 28 and 29.

HARVARD ALUMNI CHEMISTS' ASSOCIATION will meet Tuesday noon April 26 at Rochester, N. Y., for luncheon.

NATIONAL PETROLEUM CONGRESS will meet at the Hotel Baltimore, Kansas City, Mo., March 22 to 25.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS will hold a meeting in Milwaukee April 27, 28 and 29.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: March 11, American Chemical Society; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.